STUDY OF FUNCTIONAL OUTCOME OF MODIFIED TENSION BAND WIRING IN TRANSVERSE FRACTURE PATELLA

Dissertation submitted in

Partial fulfilment of the regulations required for the award of

M.S. Degree in Orthopaedics Surgery

THE TAMIL NADU Dr M.G.R. MEDICAL UNIVERSITY
CHENNAI, TAMIL NADU
April 2015

CERTIFICATE

This is to certify that the dissertation entitled "**STUDY OF FUNCTIONAL OUTCOME OF MODIFIED TENSION BAND WIRING IN TRANSVERSE FRACTURE PATELLA** " is a bonafide and genuine research work Carried out by **Dr. Prakash. T.R** in partial fulfilment of the requirement for the degree of Master of Surgery in Orthopaedics

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DECLARATION

I declare that this dissertation titled "**STUDY OF FUNCTIONAL OUTCOME OF MODIFIED TENSION BAND WIRING IN TRANSVERSE FRACTURE PATELLA**" has been prepared by me, at Coimbatore Medical College Hospital under the guidance of **Prof. Dr. S. Dhandapani,** Coimbatore Medical College Hospital, Coimbatore, in partial fulfilment of Dr. M.G.R. Tamilnadu Medical University, regulations for the award of M.S. Degree in Orthopaedics.

I have not submitted this dissertation to any other university for the award of any degree or diploma previously.

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Dr. Prakash. T.R.

M. S. Ortho Postgraduate.

ABSTRACT

INTRODUCTION

Fracture of the eccentrically loaded bone like patella is one of the most common fracture encountered by an orthopaedic surgeon.They continue to pose vexing problems as these being intraarticular are subjected to continuous deforming forces from muscles. It is also difficult to restore the desired anatomical continuity and congruity of their articular surfaces after reduction and thereby causing complications like osteoarthritis, stiffness of joints, non-union etc.In this era, fractures of patella are on an increasing note mainly resulting from road traffic accidents and hectic working schedule of a common man. Hence, with better operative techniques, internal fixation of these fractures with tension band wiring has become an accepted mode of treatment with its matching outcome results enabling the patient to smoothly resume his work without hampering his day-to-day life. Internal fixation of fractures hastens healing and rehabilitation. It also allows for early mobilization of the joint thereby preventing stiffness of joints and other complications related to immobilization.

MATERIALS AND METHODS

The study will be conducted in Coimbatore medical college and hospital during the period 2012-2015. 20 patients with transverse fractures will be included in the study.

Inclusion criteria:

1. Age above 16 years

2. Includes both sex

3. Fresh and old fractures

Exclusion criteria:

1. Age less than 18 years

2. Infected fractures

CONCLUSION

It was concluded from the present study that:

1. Tension band wiring by principle overcomes the deforming force, achieves compression at the fracture site and maintains the alignment by minimum hardware.

2. The fixation enables early active movements of joints as early as four weeks when the fracture is healing, which reduces joint stiffness.

3. The long-term complications of prolonged Joint Stiffness, Immobilization like Muscle Wasting, Pressure Sores, and osteoporosis are avoided.

4. By achieving compression at fracture site, the fracture heals faster and the patient is back to work earlier.

5. Hence, it is concluded that tension band wiring is a simple, inexpensive technique and effective means of fixing fracture based on biomechanical principle with minimum complication.

CONTENTS

Study of functional outcome of Modified Tension Band Wiring in Transverse fracture patella

INTRODUCTION

Fracture of the eccentrically loaded bone like patella is one of the most common fracture encountered by an orthopaedic surgeon. They continue to pose vexing problems as these being intraarticular are subjected to continuous deforming forces from muscles. It is also difficult to restore the desired anatomical continuity and congruity of their articular surfaces after reduction and thereby causing complications like osteoarthritis, stiffness of joints, non-union etc.In this era, fractures of patella are on an increasing note mainly resulting from road traffic accidents and hectic working schedule of a common man.Hence, with better operative techniques, internal fixation of these fractures with tension band wiring has become an accepted mode of treatment with its matching outcome results enabling the patient to smoothly resume his work without hampering his day-to-day life. Internal fixation of fractures hastens healing and rehabilitation. It also allows for early mobilization of the joint thereby preventing stiffness of joints and other complications related to immobilization.

AIM OF THE STUDY:

The aim of the study is to analyze the functional outcome of patients with transverse fracture patella treated by modified tension band wiring.

OBJECTIVES OF THE STUDY:

1. To analyze the clinical and functional outcome of patient with transverse fracture patella treated by modified tension band wiring
2. To evaluate the early benefits following surgery.
3. To analyze the early and late complications following modified tension band wiring.

REVIEW OF LITERATURE:

Conservative methods of treatment were used before 1870. The affected limb was splinted in extended portion. This allowed the fracture fragments getting approximated and the quadriceps getting relaxed. This method of treatment did not serve good for displaced fracture. End results were fracture non-union and extensor mechanism loss.

Open reduction were attempted then. Earlier open reduction and internal fixation techniques were aimed to reduce and maintain the main fracture fragments in alignment. This was made possible with the help of pins which were used percutaneously, metal loops and allograft materials like tendoachilles, fascial strips.

Malgaigne towards the end of 1800 introduced the use of bone clamps in percutaneous manner and screws in maintaining reduction. Due to high incidence of pintrack infections and joint sepsis, this method was not followed.

Open reduction was first done in the year 1877, for fracture patella by sir Hector Cameron, Scotland. He made drill holes and used silver threads for patellar reconstruction and stabilization.

In the year 1892, Berger employed the usage of wire loop in a circumferential manner. Trendelenburg and Lister employed the same in fixing patella fracture.

In the year 1936, Blodgett studied 35 patients with patella fractures being treated with open reduction and suturing of the fractured fragements with wires.

The results obtained were not satisfactory. He then opted for total patellectomy which yielded good results.

In the year 1937, Watson Jones concluded that patella interfered in the function of quadriceps and that the strength and function of knee can be improved by patellectomy. This became the choice of treatment for many years. Later lot of future studies questioned this choice of treatment. This ultimately ended in disproving Watson and Jones conclusions.

In the year 1942, Thompson recommended Patellectomy in a partial manner. In the same year Brooke published his favourable results following total patellectomy.

Later experimental studies in patellectomized rabbits by bruce et al. found that the anterior condyles were going for degenerative changes.

In the following year, Haxton et. al in their study in patients with patella and without patella, concluded the power of extension was greater in patients with patella they concluded that patella cannot be a vestigial organ.

In the year 1915, phemister employed silk sutures for direct repairing of patella fracture.

Kaufer et al, in their cadaveric study compared patellectomized with intact patella and found that the force of quardriceps required for extension in the patellectomized group was 15-30% greater. Peeples and Margo also reported extensor lag in patellectomized patients in a similar study.

In the early 1950's, Tension band technique was introduced by Pauwel.

Benjamin et. al compared different methods of fixation of patella fracture and concluded modified tension band technique offered more stability and served as the best method of fixation.

In the year 1980, Weber MJ, Janecki, Mc Leod studied various methods of fixation of transverse fractures of patella. They studied the use of circumferential wiring, tension band wiring, modified tension band wiring and magnusson wiring. Failure of implant and fragment getting separated were taken into consideration. They found that this was less in the modified tension band wiring technique and Magnusson wiring technique.

In the year1980, Weber MJ, Janecki, Mc Leod.P., Nelson CL, Thompson JA in their study concluded that for early mobilization in the treatment of transverse fracture of patella, the method that needs to be used has to have the wire in direct contact with the bone. They also reported that retinacular repair in addition helps in early mobilization.

In the year 1985, Hung LK. et. al. concluded that operative procedure for patella will have minor complications. They described wiring technique using tension band principle to be the safest. They also concluded it to be the effective technique.

Levack et al in the year 1985, reported that good results can be obtained by achieving good anatomical reduction and stable fixation. This can best achieved with the help of K-wires and a tension band.Whenever this is not possible, one may opt for patellectomy which also gave good results in such situations.

Marya et al in the year 1987, compared two group of patients one with patellectomy done and another with osteosynthesis done. They found only half of the patellectomy patients had excellent results.Nearly 80% of patients of with osteosynthesis done had excellent results. This has led to their conclusion that whenever there is a possibility, patella fracture needs to be reduced accurately and treated with tension band wiring.

Benjamin et al in the year 1987, studied modified tension band technique along with other methods of fixation of patella fracture like Magnusson wiring, screw fixation and Lotke's longitudinal anterior band. In patients with good bone quality, they recommended screw fixation for transverse fracture patella. In cases of comminted fracture and patients who are osteopenic, they suggested modified tension band wiring technique. They also concluded that tension band wiring when compared to modified tension band wiring offered less stability.

In the year 1990, Curtis M.J. et.al, studied both modified tension band wiring and the technique involving both simple tension band wiring with cerclage. They concluded that tension band wiring along with cerclage offered more stability.

In the year 1993, Hung LK et al studied the combination of partial patellectomy with figure of eight tension band extending from patella to tibial tuberosity. They reported a high incidence of osteoarthritis in this technique.

Burvant JG et al in the year 1994, studied various methods of fixation of patella fracture. They concluded that screw fixation together with tension band wiring offered more stability. The gap in the fracture site reduced significantly by employing this technique when compared to modified tension band wiring. They found that the use of screws brought about more compression when the knee is flexed and also resisted the tensile loading when the knee is extended. This mechanical advantage gave superior results compared to modified tension band wiring.

In the year 1997, Berg EE et al studied and compared fixation methods with modified tension band wiring in the treatment of patella fracture. They reported that fixation methods led to lesser irritation to soft

tissues and also because of their stability helped the patients to mobilize earlier. This technique also helped in three osteopenic patients where tension band technique failed.

In the year 1997, Carpenter et al studied three methods of fixation of transverse patella fracture. They concluded that screw fixation along with tension band offered more stability when compared to screw fixation alone and modified tension band wiring alone. They used cannulated screws and found them be simpler and more reliable.

In the year 1998, Chatakondu SC et al used a special non absorbable suture material made of polyester instead of SS wire in treatment of patella fracture. They gave good results with seven patients. All these patients had good union and knee function.

In the year 1998,Chen A et al in their study of treatment of patella fracture used metallic implants which were biodegradable by modified tension band technique. They studied 38 patients fracture patella treated by using this implant. By using this,they avoided the need for a second surgery in the form of exit of implant after achieving bone union.

In the year 2001, Gosal HS et al studied 37 patients of patella fracture fixed using polyester non absorbable suture material and metal wires. They found that the group treated with metal wires had high infection rate. When compared with patients fixed with polyester non absorbable suture material. Thus groups fixed with metal wires had more patient morbidity.

In the year 2003, Yang KH et al studied comminuted fracture involving inferior pole of patella. They used vertical wires to fix them and observed healing around seven weeks.They reported that besides fixing the fragments, this technique helped in maintaining the patellar length and aided in earlier mobilization. Complications like wire breakage and infection were not observed.

In the year 2005, Gardener Michael J et al studied tension band wiring method in the treatment of patella fracture. They concluded that whenever possible this method has to be employed. Better results can be achieved in pure transverse fracture of patella.

Tomoji Matsuo et al in the year 2014, in their study “percutaneous cerclage wiring for displaced patella fractures” involving five patients reported bone union in four patients and separation of fractured fragment in one patient. In their study they have taken into account the atraumatic

manipulation of peripatellar soft tissues which aided in extensor mechanism. Though this procedure is not simple, they concluded that this may serve as superior fixation method when compared to other fixation techniques in cases of highly comminuted fracture with minimal displacement.

Shrestha et.al in 2009, studied 36 patients with displaced transverse fractures of patient treated by Modified tension band wiring concluded that proper following of rehabilitation protocol post operatively, better functions can be achieved earlier

Syed Mujahid Humail et.al in 2009 studied 45 patients with transverse fractures patella with displacement more than 3mm, concluded that Tension band wiring allows early motion and rehabilitation.

K.Srinivas et.al in 2004, studied 32patients with closed fractures patella concluded that Osteosynthesis with modified Tension Band wiring gives the best result as the normal anatomy is being restored.

S.Abdulhussein Mehdinasab et.al in 2013,in their study of Assessment Results of patellar fractures treatment after Tension Band wiring with 24 patients concluded that fixation of patellar fractures with Tension Band wiring was associated with high rate of union.

K.A.Lefaivre et.al in 2010,in a study of 31 patients with patellar fractures treated with modified tension band wire technique has found the technique to be useful as a part of the treatment of comminuted and simple fractures of the patella.

Onder Baran et.al in 2008,in their study "Anatomical and biomechanical evaluation of the tension band technique in patellar fractures" with 30 patients concluded that tension band is the main stability factor in patellar fractures in flexion and more stability and durability can be achieved by transferring the tension force directly on to the bone .

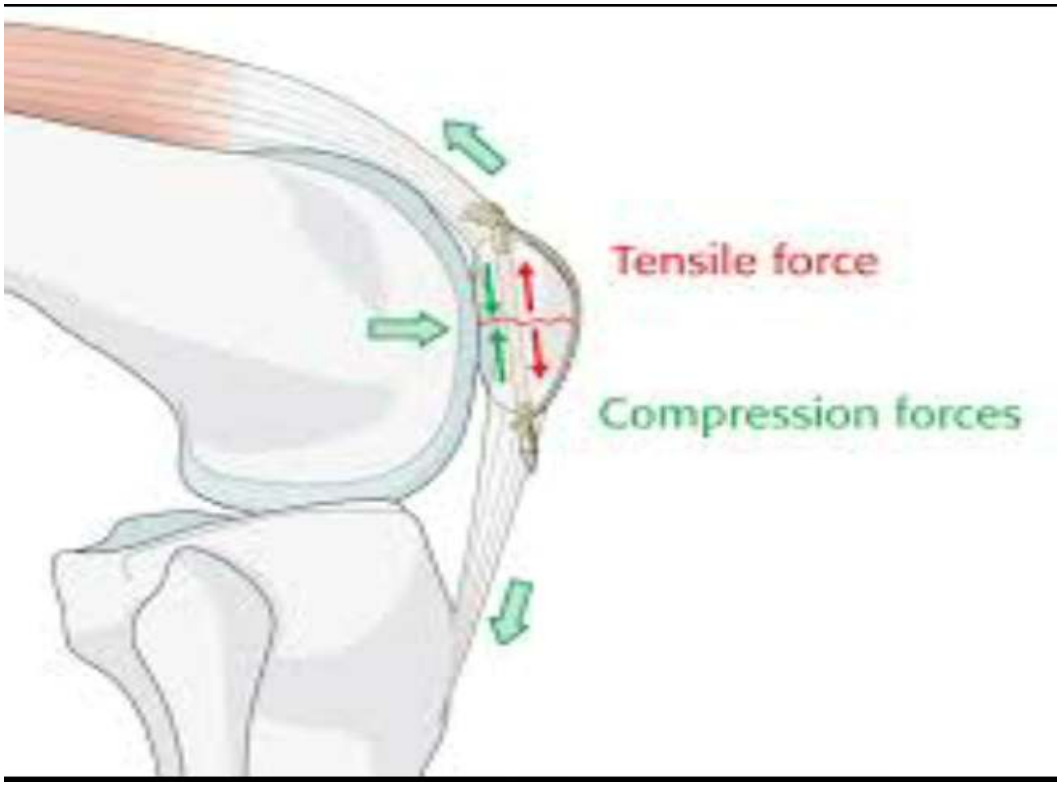
Scott.T.Smith et.al in 1997 in their study "Early complications in the Operative Treatment of Patella Fractures" with 87 patients with 5year follow up found 22% of fractures treated with tension band wiring and early motion displaced >= 2mm within early post operative period. Technical error or patient noncompliances were identified as factors.

Christopher Le Brun et. al in a study involving 40 patients surgically treated for patella fractures demonstrated that overall long term functional outcomes after patella fractures are not encouraging.

PRINCIPLES OF TENSION BAND WIRING

Principle

The distractive forces at fracture site are converted to compressive force. The implant absorbs the tension and the bone compression.



Dynamic compression with tension band

The dynamic compression is one when the fragments are not only compressed by pre-stress of the implant but also are subjected to additional compression, which results from harnessing forces generated at the level of the fracture when skeleton comes under normal physiological load.

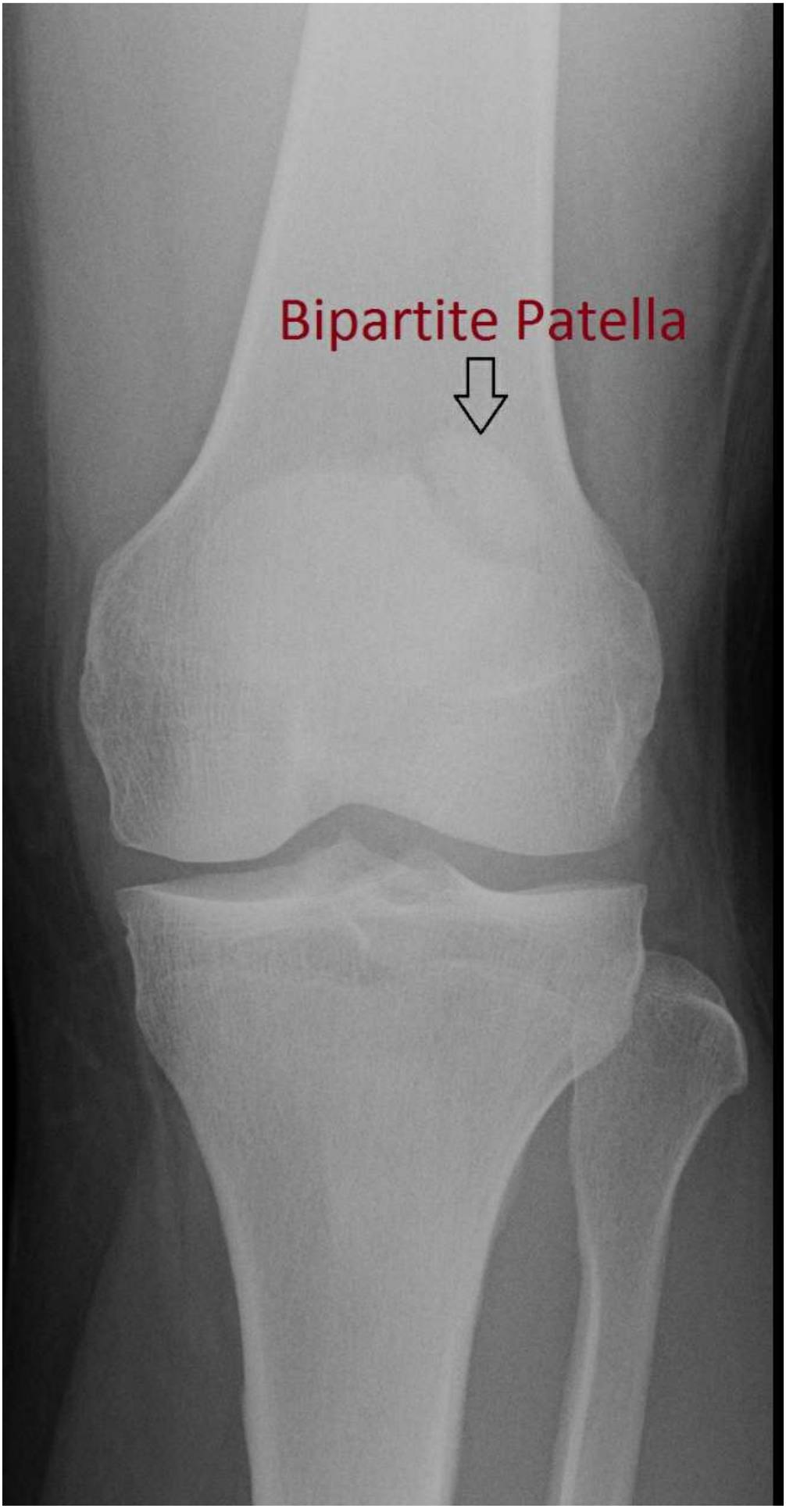
It was Pauwel who first borrowed from industrial mechanics the principle of tension band fixation and demonstrated its application in internal fixations of bone. Every eccentrically loaded bone is subjected to bending stresses. This results in a typical distribution of stresses with tension on the convex and compression on the concave side of the bone. This is also why when such a bone fractures, it displaces with a gap on the tension side. In order to restore the loading capacity of an eccentrically loaded fractured bone, the tensile forces have to be absorbed by a tension band wire and the bone itself has to be able to withstand axial compression. The pre-stressing of the device in tension results in interfragmental compression.

Advantages of Tension Band Wiring

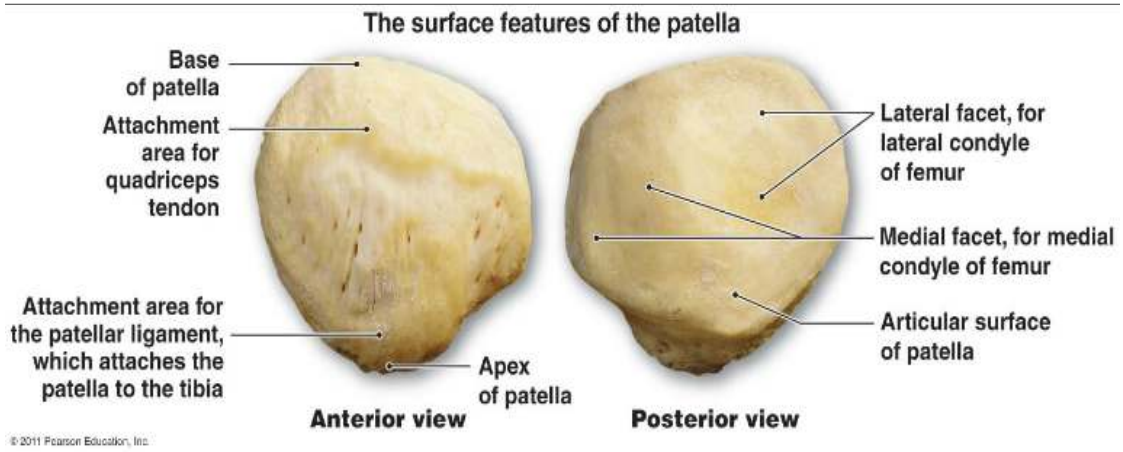
- It is inexpensive and effective method of internal fixation.
- Less cumbersome
- Good patient compliance
- Early mobilization of the joint is possible.
- Maintains the approximate continuity of the bone without affecting the healing process even after the joint is mobilized.

ANATOMY PATELLA

The patella is the largest sesamoid bone in the body and lies within the quadriceps tendon. The ossification center usually appears at 2 to 3 years of age, but its appearance may be delayed until as late as 6 years. Anomalies of ossification usually are related to an accessory ossification center located at the superolateral corner of the patella. This is called the bipartite patella. If a similar lesion is present on the radiograph of the opposite knee, the diagnosis is clear. If not, special radiographic views, including CT, may be necessary to differentiate it from nonunion of a patellar fracture. Stress fractures of the patella may be difficult to diagnosis and are often seen in osteopenic elderly patients complaining of anterior knee pain after minor trauma. Bone scanning of the patella several days after injury may reveal "hot areas" corresponding to the patient's symptoms and confirming the diagnosis.


Bipartite Patella

The patella is triangular with the apex directed distally. The proximal patellar pole is broad and thick and receives the insertion of the rectus femoris and vastus muscles (lateralis, medialis, and intermedius). Most of the quadriceps aponeurosis inserts into the superior pole of the patella. The medial and lateral margins of the patella receive fibers from the vastus medialis and lateralis, respectively. The distal pole or apex provides the origin of the patellar tendon, which inserts into the tibial tubercle. A thin layer of quadriceps tendon associated with thick Sharpey's fibers passes over the anterior surface of the patella, joining the patellar tendon distally. The posterior three-fourths of the patella is covered by articular cartilage and is divided into major medial and lateral facets that articulate with the anterior trochlea of the distal femur.



The blood supply to the patella is formed by an extraosseus anastomotic ring within the loose connective tissue lying over the extensor mechanism connective tissue.

There are several vessels that contribute to this anastomotic ring, including a central superior geniculate vessel, medial and lateral superior and inferior geniculate vessels, and an inferior recurrent tibia vessel. The primary blood supply of the patella enters the bone by way of the anastomotic vessels through the middle of the anterior portion of the body of the patella and through the distal pole vessels. This relationship is important in understanding the mechanism of avascular necrosis as a sequela of patellar fractures.

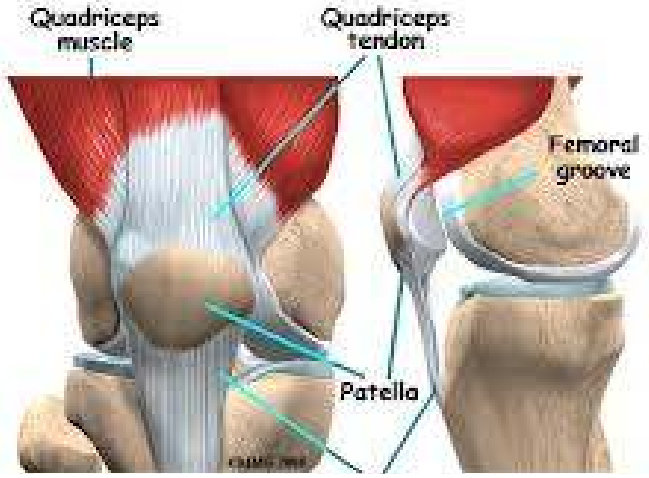
Fractures through the midportion of the patella, especially transverse fractures with displacement, interrupt the main nutrient arteries ascending from the central portion of the patella and leave the proximal

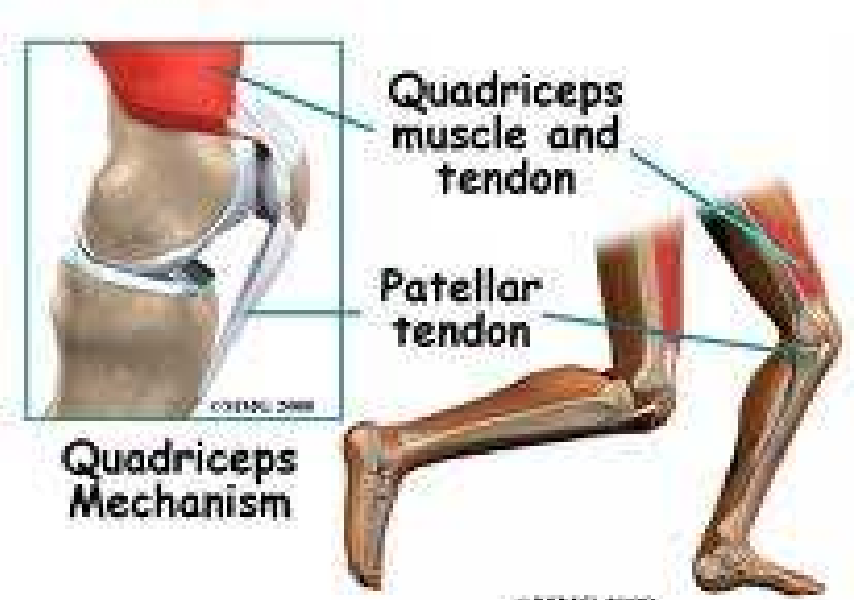
pole and, to a lesser degree, the central portion of the patella at risk for avascular necrosis. The inferior pole tolerates this vascular insult better because of the dual blood supply originating from the midpatellar and inferior pole vessels that remain intact after transverse fractures. The incidence of avascular necrosis has been reported to range from 3.5% to 24%. Avascular necrosis may develop after conservative treatment but is more often seen after internal stabilization of fractures treated with circumferential repair that occludes peripatellar vessel blood supply.

Avascular necrosis is frequently diagnosed within 1 to 2 months after fracture with radiographic evidence of sclerosis of either the proximal or the distal pole fragment. The presence of avascular necrosis does not dramatically affect patellar function immediately.

Healing of the fracture will usually occur if appropriate fixation is applied. Scapinelli reported a series of 41 cases of avascular necrosis of the patella with no significant loss of function and some degree of patellofemoral arthritis many years after fracture. It was often the practice in the past to excise either superior or inferior pole patellar fragments because of the potential for avascular necrosis or the likelihood of obtaining an anatomical reduction with stable internal fixation was deemed too difficult. In light of the lack of significant residual sequelae after repair of patellar fractures, the practice of routinely resecting major

fragments or polar fragments is to be condemned in favor of anatomical reconstruction of the patella and preservation of the extensor mechanism whenever possible.





RANGE OF MOTION

The knee joint is both a hinge and a pivot joint. The full range of motion of knee extends from 10 degree extension to 140 degree flexion.and Flexion and extension involve both rolling and sliding motions.

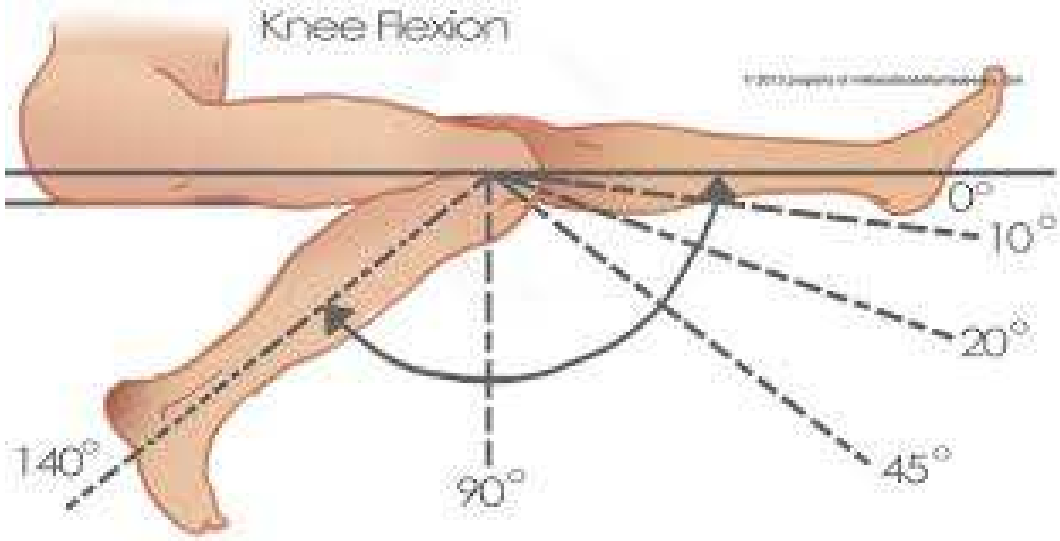
The functional range of movements during various activities is given in the following table

Functional range of motion (ROM) at the knee

Activities	Knee flexion
◆ Normal gait/level surfaces	60°
◆ Stair climbing	80°
◆ Sitting/rising from most chairs	90°
◆ Sitting/rising from toilet seat	115º
◆ Advanced function	> 115°

Rotation and translation in knee joint

- **Rotation:**
  - flexion-extension: up to 160 deg of flexion
    (up to -5 deg flexion – hyperextension)
  - varus-valgus: 6-8 deg in extension
  - internal-external rotation: 25-30 deg in flexion
- **Translation:**
  - anterior-posterior: 5–10 mm
  - compression: 2–5 mm
  - medio-lateral: 1-2 mm



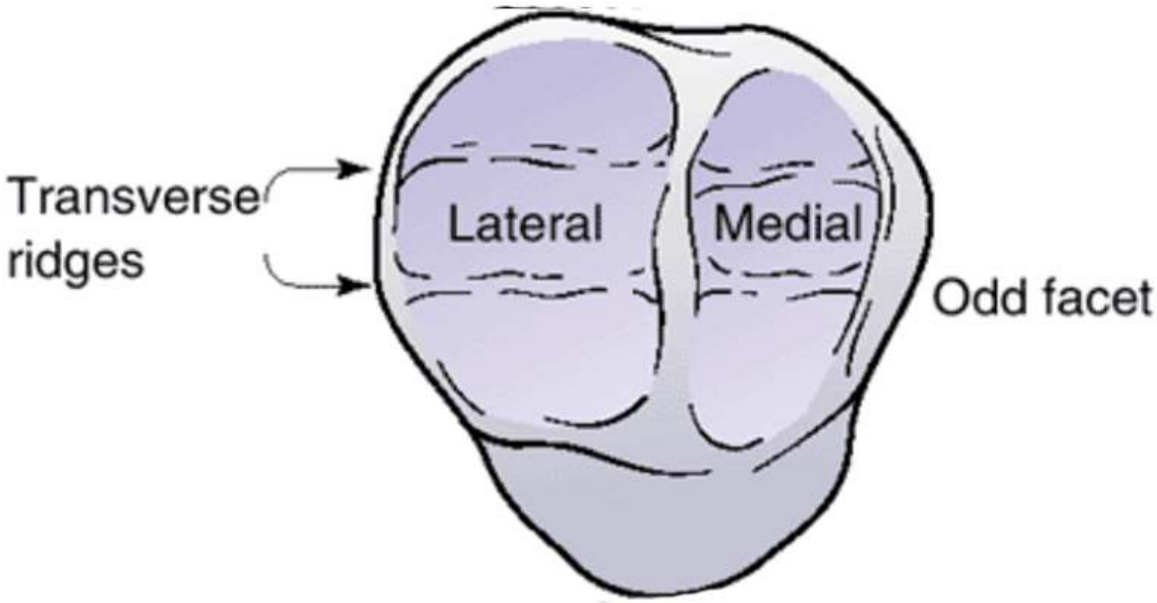
KNEE FLEXION

KNEE EXTENSION

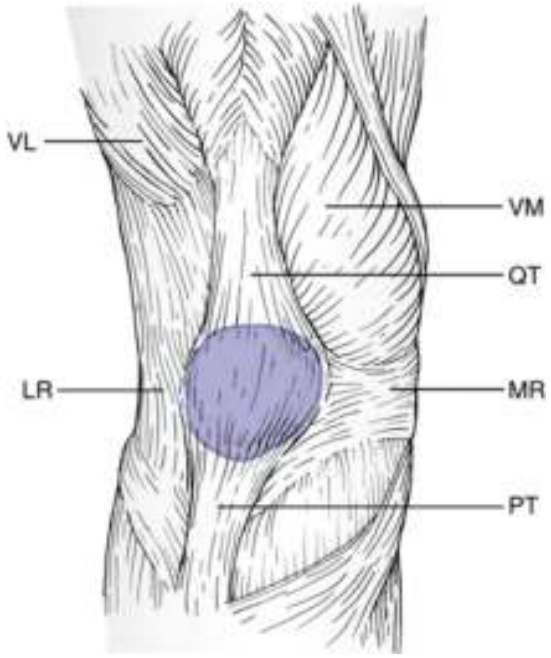
BIOMECHANICS OF PATELLA

The functions of the patella are to increase the mechanical advantage of the quadriceps tendon, aid in nourishment of the anterior articular surface of the femur, and protect the femoral condyles from injury. The patella transmits the tensile forces of the quadriceps muscle to the patellar tendon. The patella improves the efficiency of the quadriceps muscle by elevating the extensor mechanism from the axis of rotation of the knee joint. It also increases the leverage of the quadriceps muscle by making it act over a greater angle. Daily activities generate patellofemoral compressive forces of greater than three times body weight, while forces generated with stair climbing and deep squatting may exceed seven times body weight. Tensile forces across the patella may reach 3000 N and may increase to 6000 N in athletes. Several authors have estimated patellofemoral contact stresses of 2 to 10 N/mm2, nearly double the estimated tibiofemoral contact stresses of 2 to 5 N/mm2. These estimates provide evidence for the importance of maintaining anatomical articular reduction and rehabilitation of the knee after patellar fracture to maximize stress distribution across the patellofemoral joint.

The patellar cartilage articulates with the anterior surface of the femoral condyles. The area of contact between the patella and the femur varies according to the position of the knee. With the knee extended, the lower portion of the patella is in contact with the femur. Increasing knee flexion brings first the middle and then the upper portion of the patella into contact with the anterior femoral condyle. The posterior articular surface of the patella is divided by a vertical ridge into two major surfaces, the medial and lateral facets. This ridge articulates with the anterior distal femoral articular groove. Inferior to the patellar articular surface is a rough non-articular area, the distal pole. This portion of the patella provides the attachment of the patellar tendon.



The medial and lateral extensor retinacula, or "expansions," are composed of longitudinal fibers of the vastus medialis and vastus lateralis. The vastus lateralis combines with fibers of the fascialata that bypass the patella and insert directly into the upper tibia at Gerdy's tubercle. Preservation of these medial and lateral expansions along with intact anterior fascia and Sharpey's fibers allows active extension of the knee after patellar fracture. This is an important fact in both diagnosis and treatment.



VL – vastus lateralis

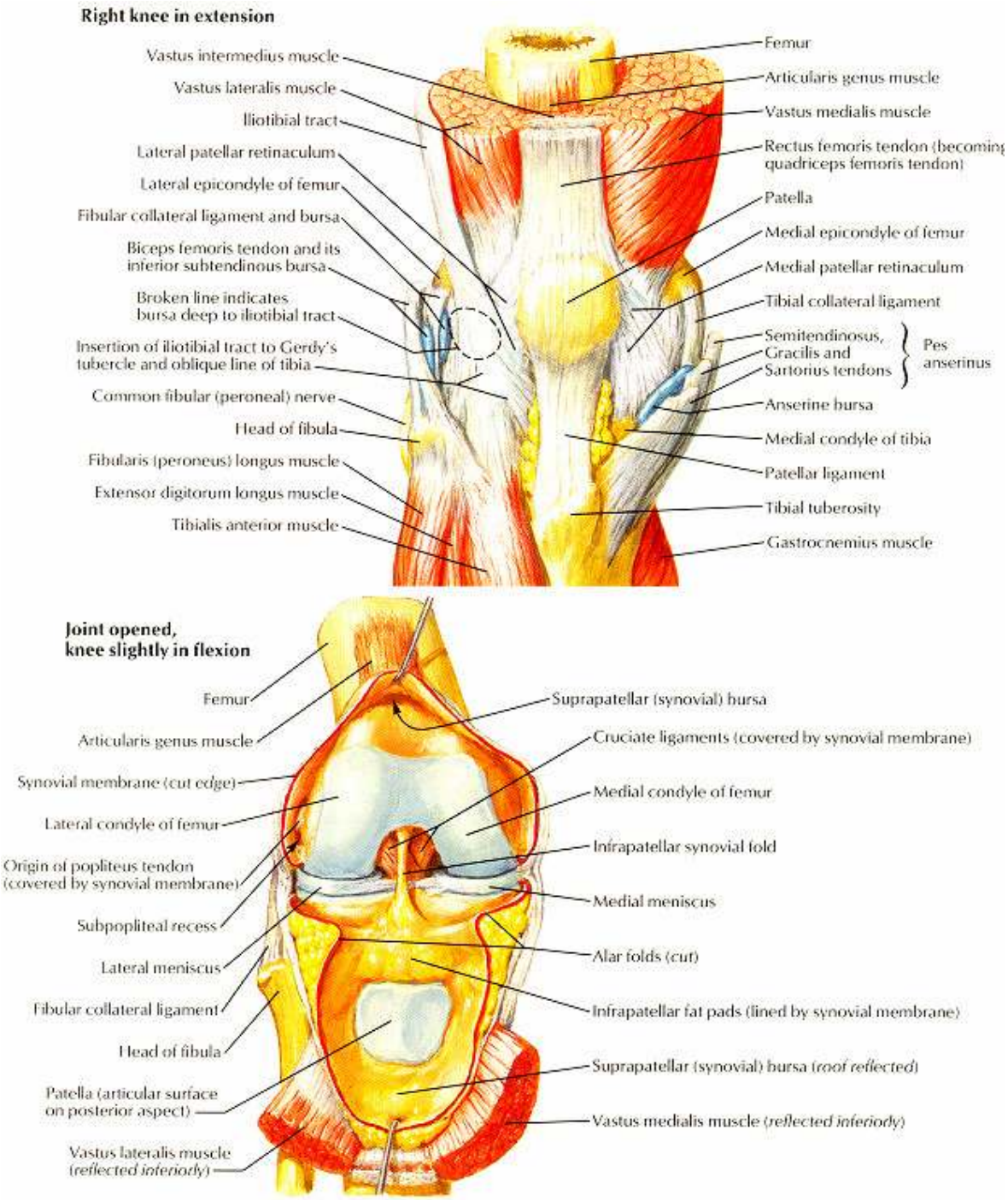
VM –vastus medialis

QT – quadriceps tendon

LR – lateral retinaculum

MR – medial retinaculum

PT – patellar tendon


Right knee in extension
Vastus intermedius muscle
Vastus lateralis muscle
Iliotibial tract
Lateral patellar retinaculum
Lateral epicondyle of femur
Fibular collateral ligament and bursa
Biceps femoris tendon and its inferior subtendinous bursa
Broken line indicates bursa deep to iliotibial tract
Insertion of iliotibial tract to Gerdy's tubercle and oblique line of tibia
Common fibular (peroneal) nerve
Head of fibula
Fibularis (peroneus) longus muscle
Extensor digitorum longus muscle
Tibialis anterior muscle
Femur
Articularis genus muscle
Vastus medialis muscle
Rectus femoris tendon (becoming quadriceps femoris tendon)
Patella
Medial epicondyle of femur
Medial patellar retinaculum
Tibial collateral ligament
Semitendinosus, Gracilis and Sartorius tendons
Pes anserinus
Anserine bursa
Medial condyle of tibia
Patellar ligament
Tibial tuberosity
Gastrocnemius muscle
Joint opened, knee slightly in flexion
Femur
Articularis genus muscle
Synovial membrane (cut edge)
Lateral condyle of femur
Origin of popliteus tendon (covered by synovial membrane)
Subpopliteal recess
Lateral meniscus
Fibular collateral ligament
Head of fibula
Patella (articular surface on posterior aspect)
Vastus lateralis muscle (reflected inferiorly)
Suprapatellar (synovial) bursa
Cruciate ligaments (covered by synovial membrane)
Medial condyle of femur
Infrapatellar synovial fold
Medial meniscus
Alar folds (cut)
Infrapatellar fat pads (lined by synovial membrane)
Suprapatellar (synovial) bursa (roof reflected)
Vastus medialis muscle (reflected inferiorly)

CLASSIFICATION OF FRACTURES

PATELLA

Orthopaedic trauma association classification

1. Nn-displaced: Transverse
   Stellate
   Vertical

2. Displaced: Transverse
   Stellate
   Polar - Proximal and Distal

3. Osteochondral

AO Classification

A: Patella extra-articular

A1: Patella extra-articular avulsion

A2: Patella extra-articular, isolated body

B:

Partial articular, extensor mechanism intact

B1: Partial articular vertical, lateral

1. Simple

2. Multifragmentary

B2:

Partial articular, vertical, medial

1. Simple

2. Multifragmentary

B3:

Partial articular, multifragmentary

C:

Complete articular, disrupted extensor mechanism

C1: Complete articular, transverse

1. Middle
2. Proximal
3. Distal

C2:

Complete articular, transverse plus two fragments

1. Middle
2. Proximal
3. Distal

C3:

Complete articular, complex

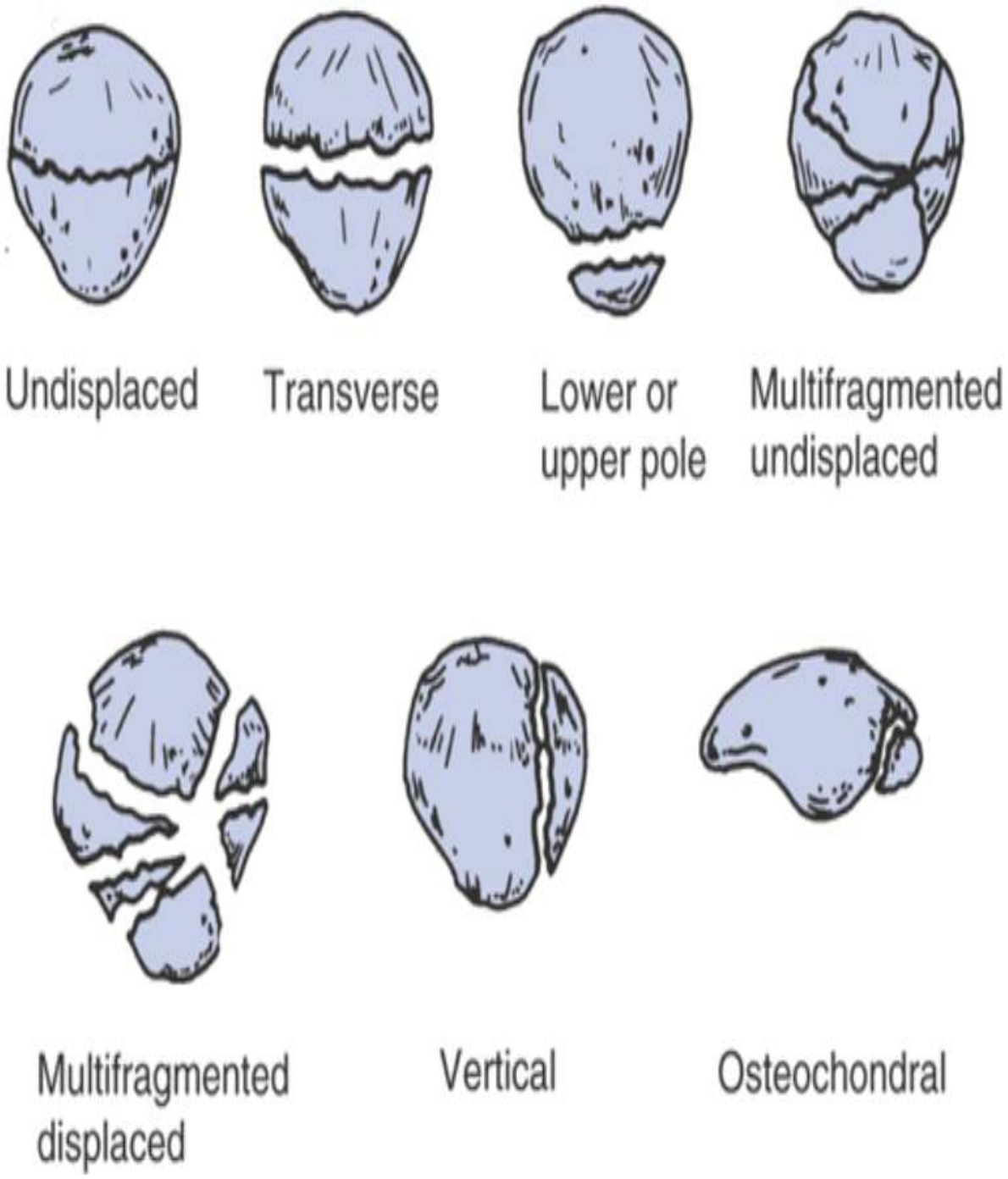
1. 3 fragments
2. > 3 fragments
3. Non-reconstructible

Displaced fractures: It is defined displaced, if fractures fragment separation is more than 3 mm or an articular incongruity of 2 mm or more.

Multifragmented fractures (Stellate fracture result from direct compression with varying degrees of communition and displacement.

Unusual fracture patterns: Kroner first described osteochondral fractures, which are usually seen in patients 15 to 20 years of age. These fractures involve either the medial facet of patella or lateral femoral condyle after subluxation or dislocation of patella.

Classification of patellar fractures



PATELLAR FRACTURES

Mechanism of injury

Patella fractures account for 1% of all skeletal fractures and seen in age of 20 to 50 years.Incidence in men is almost twice that in women. Patella fractures result from direct or indirect forces. Majority occurs from direct injuries such as blow to the patella from a fall, motor vehicle crash. Indirect injuries occur from a near fall, fall from a height or combination. This type of injury occurs when the forces from extensor mechanism exceeds the intrinsic strength of patella.

Once bony failure occurs, the injury may continue through the medial and lateral expansions of quadriceps by the pull of the muscle. This injury usually results in a transverse fracture with some inferior pole comminution and fragment displacement is dependant on the amount of damage to the quadriceps retinaculum.

Transverse fractures result from excessive longitudinal forces. Stellate fractures are caused by high-energy direct blow to the patella.

Signs and symptoms

Patients present with pain, swelling, defect and decreased strength of the knee. Palpation reveals tenderness, gap between the fracture fragment segments and hemarthrosis. Abrasion, contusion over the knee may be noticed.

PATELLA FRACTURE PRESENTING WITH DEFECT

ABRASION/CONTUSION

Abrasion, contusion over the knee should be examined for communication with knee joint by saline test as open patella fracture is a surgical emergency and requires debridement within 6 to 8 hours

OPEN FRACTURE

Damage to the extensor mechanism is tested by active knee extension.

Injection of local anesthetic into the joint can eliminate the pain and facilitate the performance of test.

Full active extension against gravity only indicates an intact extensor mechanism and does not rule out presence of fracture.

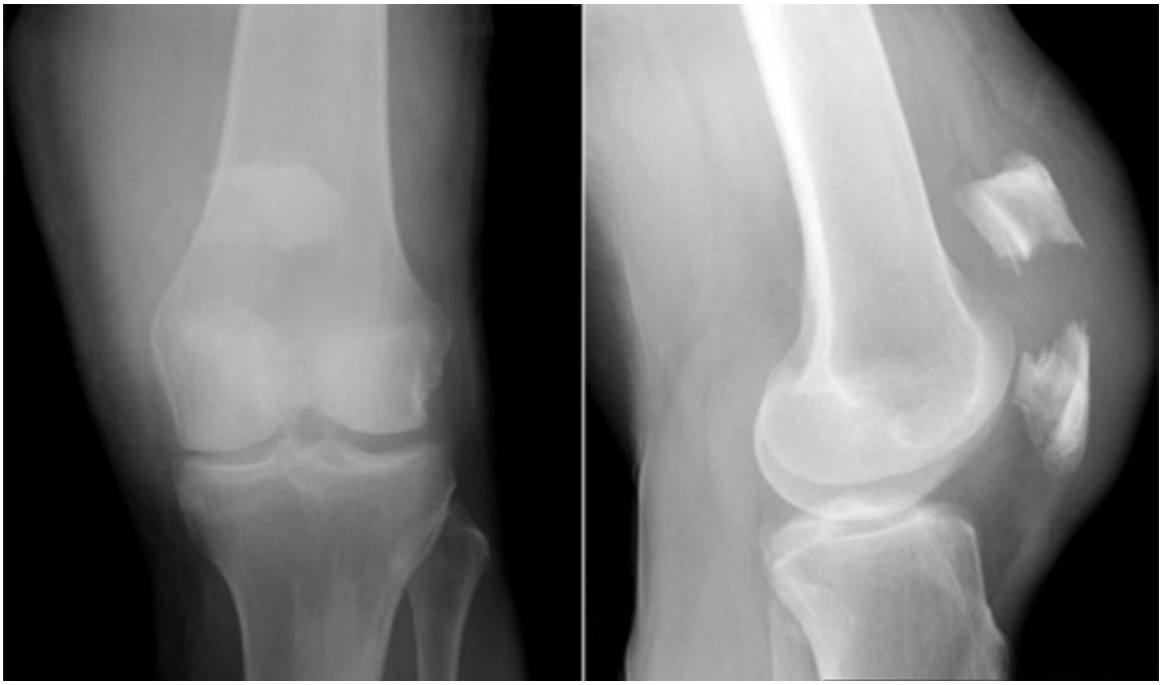
Radiographic evaluation

Antero-posterior, lateral, axial (skyline) views are routinely used in the evaluation of patellar fractures.

AP radiographs may be difficult to evaluate due to secondary superimposition of distal femoral condyles.

Lateral views provide fracture displacement, patellar position and congruity of articular surface.

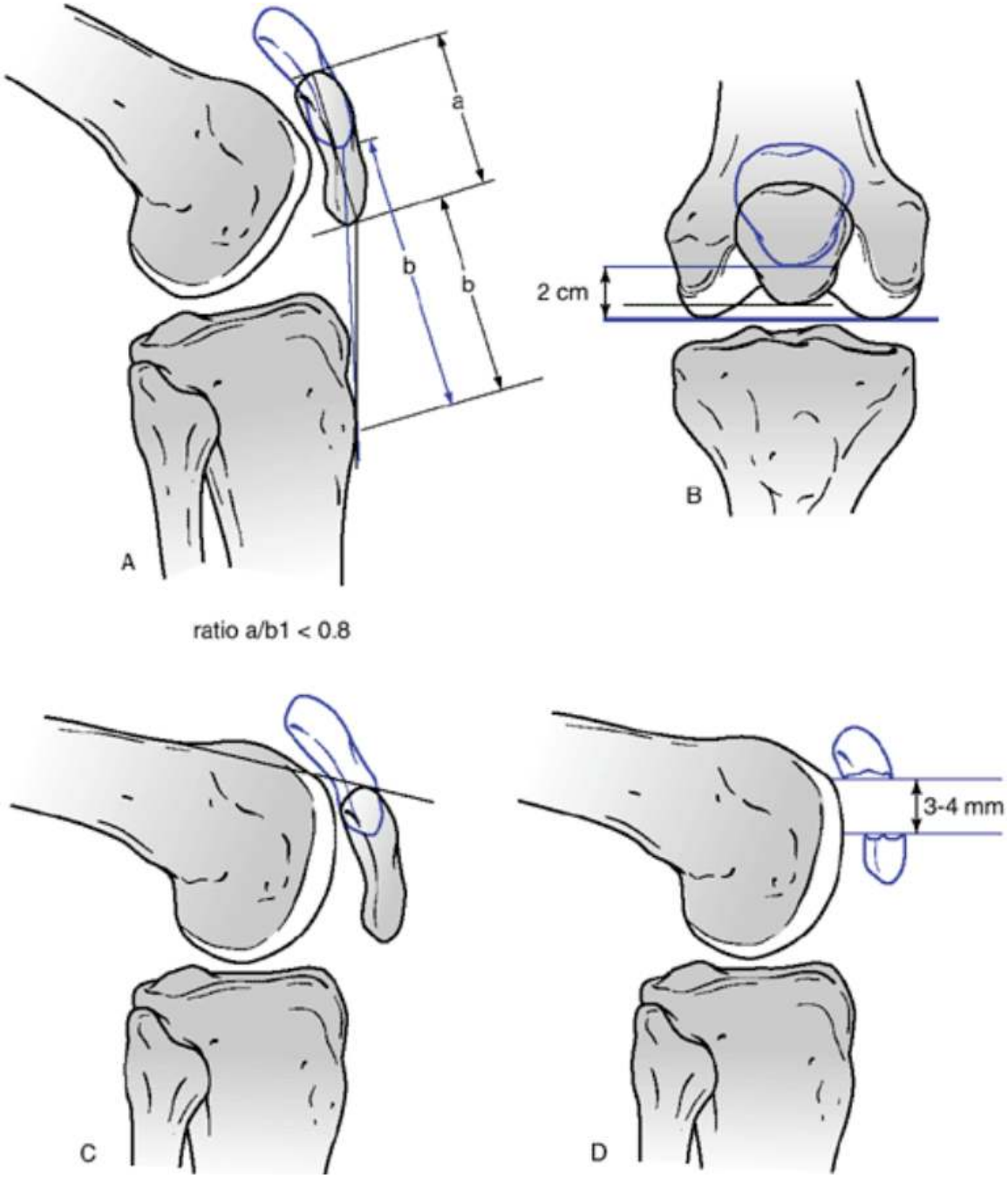
AP AND LATERAL X-RAYS OF LEFT KNEE SHOWING TRANSVERSE FRACTURE PATELLA



A low riding patella or patella Baja may indicate rupture of quadriceps tendon. A high riding patella or patella Alta may be a sign of patellar tendon rupture.

The position of patella is assessed using the ratio of greatest diagonal patellar length to patellar tendon length. Normally the ratio is 1. The ratio is less than 0.8 suggest high riding patella or patellar tendon rupture.

PATELLAR POSITION ASSESSMENT



The patella should lie in the middle of femoral sulcus.

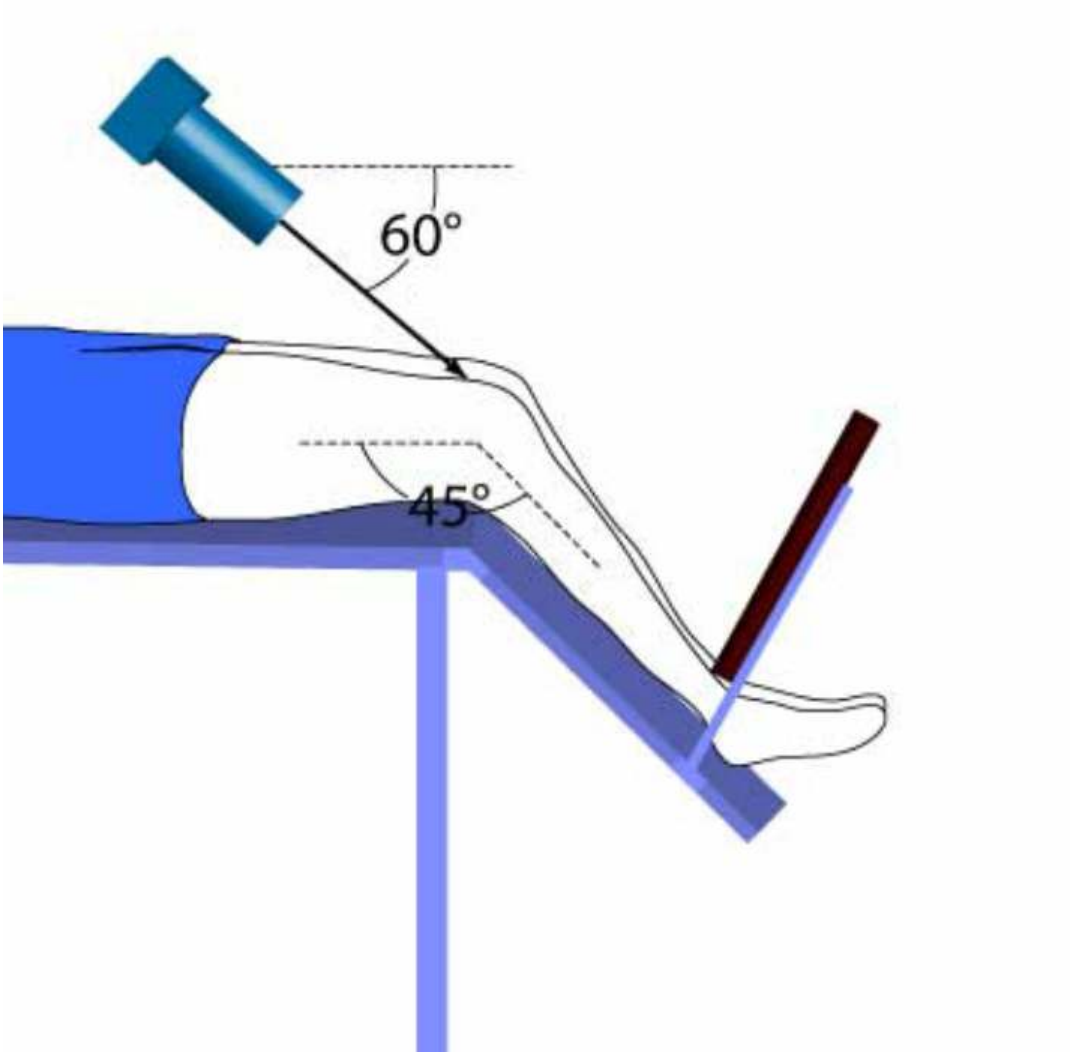
In AP view the inferior pole or patella should lie within 2 cms of a plane formed by distal femoral condyles.

In lateral view, the proximal pole of the patella should lie below the anterior surface of the femoral shaft with knee flexed to 90 degrees.

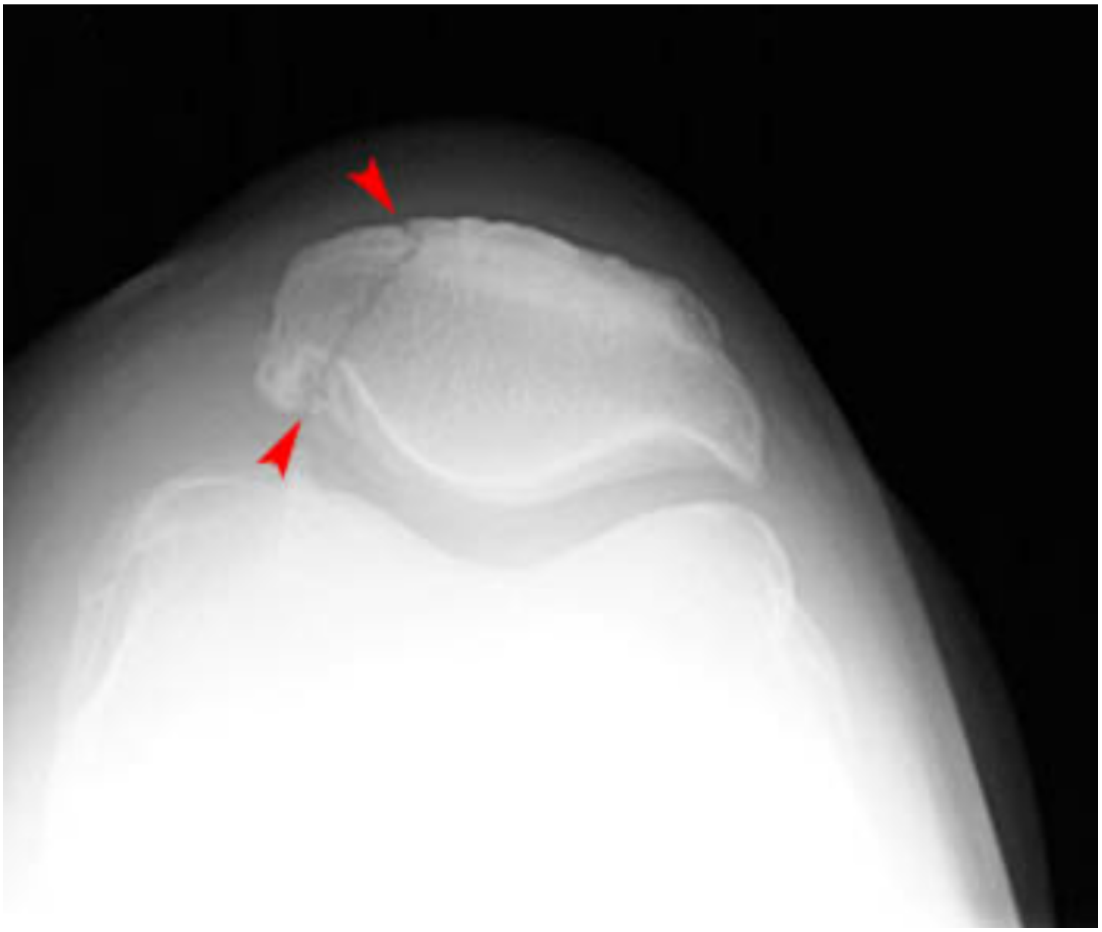
Axial view can demonstrate a vertical fracture and osteochondral defects.

Axial view (Merchant view): This view is obtained with patient's supine on x-ray table and knee flexed to 45degrees. The x-ray beam is angled to 30 degrees from the horizontal and the cassette is placed perpendicular to the x-ray beam.

SKYLINE/MERCHANT VIEW



SKYLINE VIEW SHOWING FRACTURE PATELLA



Management of patella fractures

It is based on the type of fracture.

The goals of treatment are:

1. Preserve the patella function.

2 Restore continuity of extensor mechanism

3. Reduce complications associated with articular surface.

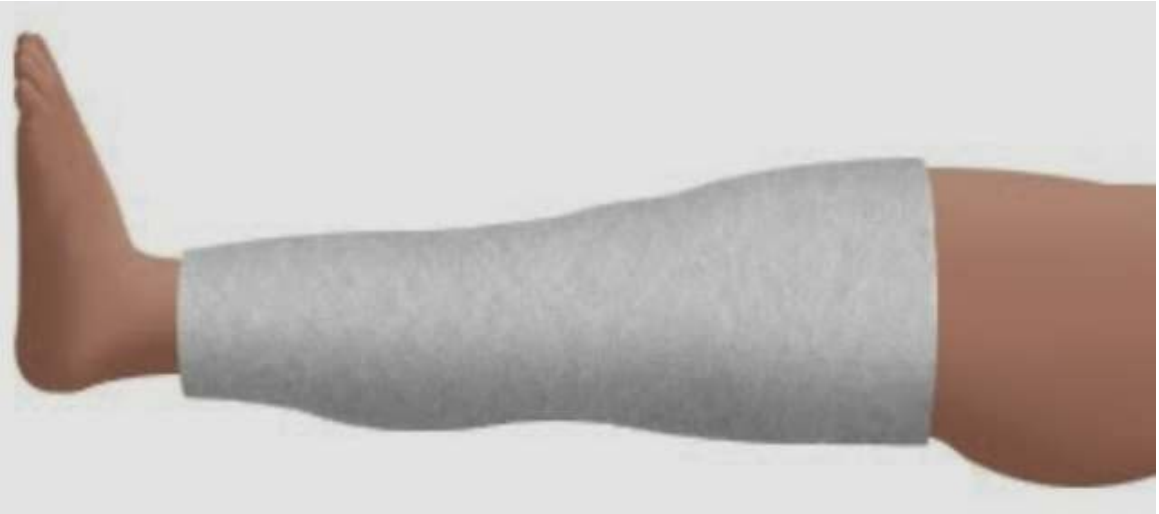
Treatment options include:

1.**Non-operative treatment**: It is indicated for

• Non-displaced fractures with an intact extensor mechanism.

• Fragment displacement less than 3 mm or articular displacement more than 2 mm.

•A cylinder cast is applied with knee in extension from groin to just above ankle.



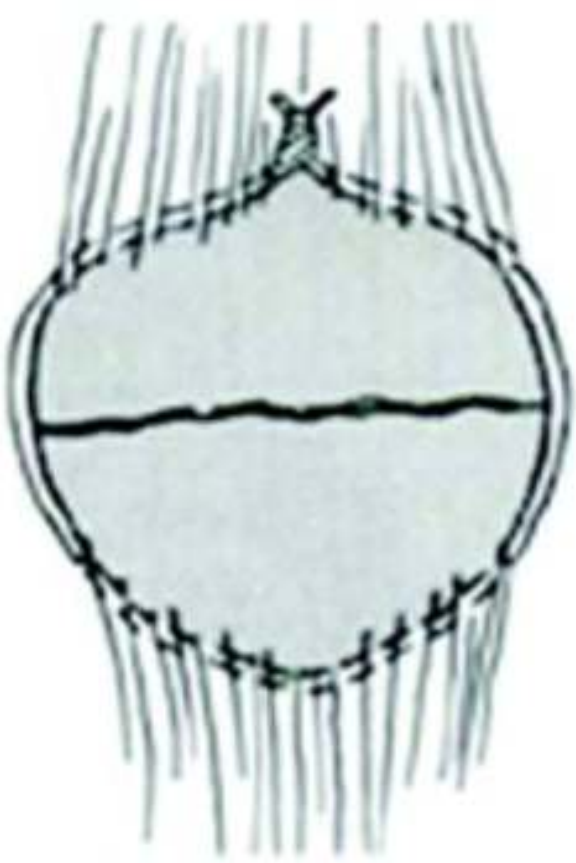
Operative treatment: It is indicated for:

- ❖ Displaced fractures for more than 3 mm separation of fragments.
- ❖ Articular displacement more than 2 mm
- ❖ Comminuted fractures.
- ❖ Osteochondral fracture with displacement of loose body in the joint.
- ❖ Open fractures

Types of patellar fixation

1. **Circumferential wire loop fixation**

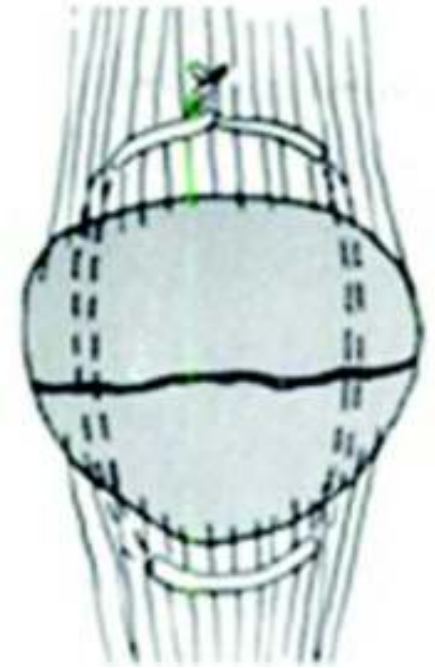
A wire loop is threaded though the soft tissues around the patella. Rigid fixation is not achieved and hence it is largely been replaced by more rigid fixation techniques to permit early motion of the joint.



2. **Magnusson wiring**

Two holes are made through the proximal fragments beginning at the medial or lateral borders of the quadriceps tendon and directed obliquely downwards to open on the fracture surface. Two holes in the distal fragment are drilled and their apertures are faced opposite to those of the proximal fragment. Stainless steel wire is threaded distally through the medial holes and then proximally through the lateral holes. After opposing the fragments the ends of the wire are drawn taut and twisted together.

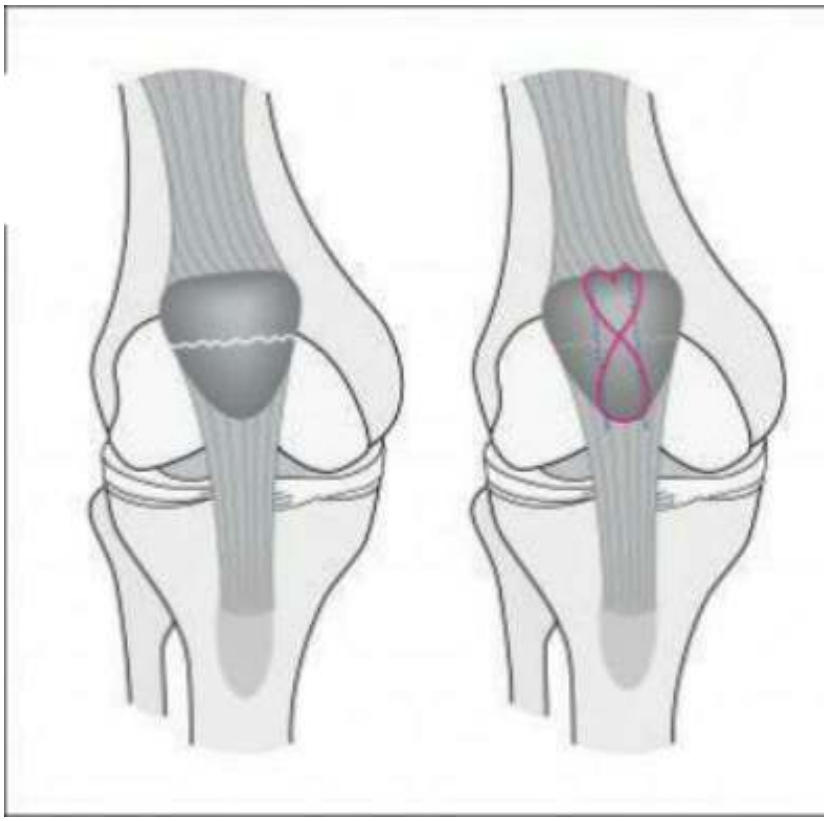
MAGNUSSON WIRING



3. **Tension band wiring**

Here two sets of wires are used, one passed transversely through the insertion of quadriceps tendon immediately adjacent to the superior pole then passing anteriorly over the superficial surface of patella and in a similar way through the insertion of patellar tendon. The wire is tightened until the fracture is slightly over corrected or opened on the articular surface. The second wire is passed through transverse holes drilled in the superior and inferior poles of the anterior patellar surface and tightened.

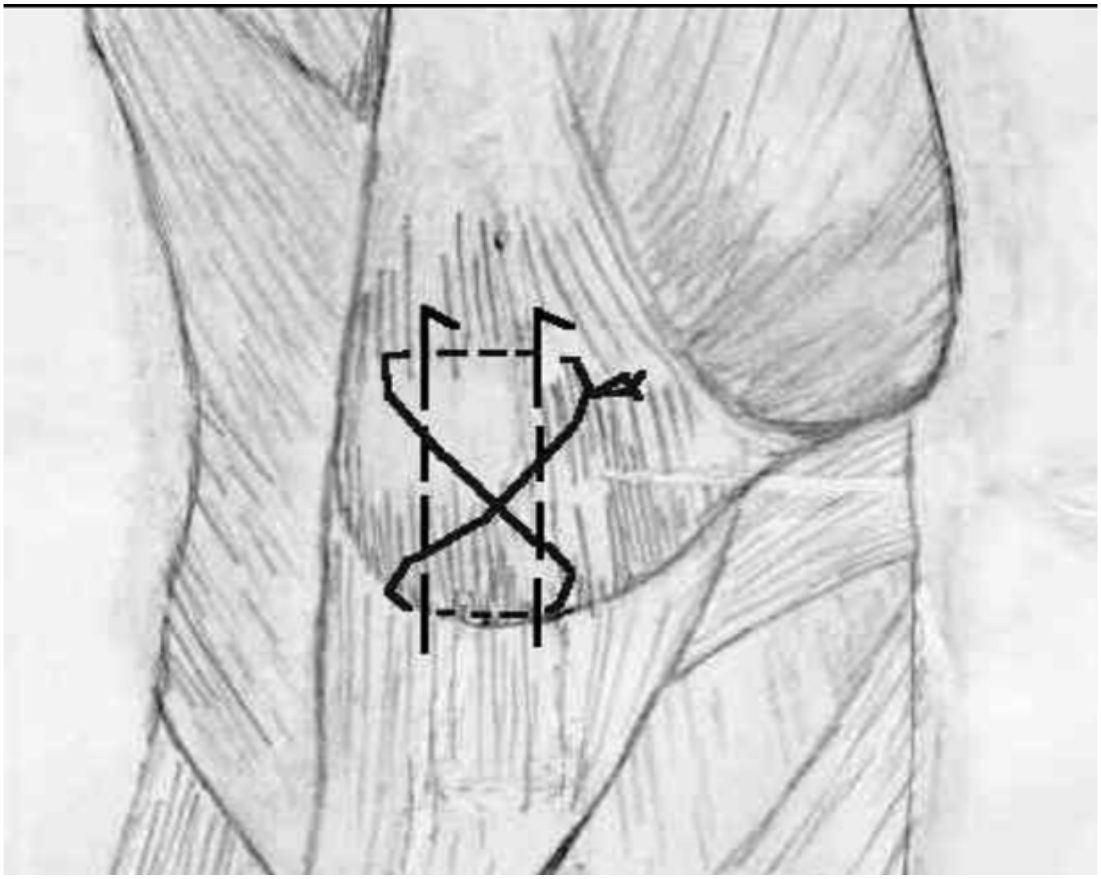
TENSION BAND WIRING



4. **Modified tension band wiring**

Two Kirschner wires are drilled from the inferior to superior poles through each fragment as parallel as possible. 18-gauge wire is passed transversely through the quadriceps tendon attachment deep beneath the protruding Kirschner wires, then over the anterior surface of the reduced patella, then transversely through the patellar tendon attachment on the inferior fragment and deep beneath the protruding Kirschner wires, then back over the anterior patellar surface in a figure of eight fashion and then tightened at the upper end.

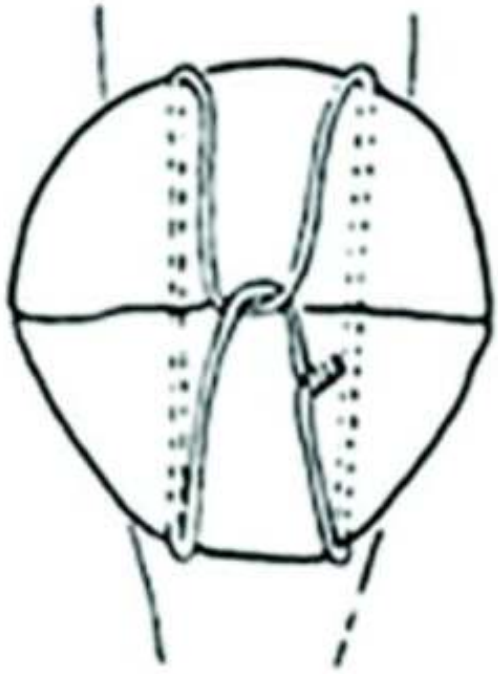
MODIFIED TENSION BAND WIRING



5. **Lotke longitudinal anterior band wiring**

A steel wire is passed through a hole drilled on the medial side of each fragment passing at the lower border and then through a hole drilled on the lateral side and tightened at the upper hole.

LOTKE LONGITUDINAL ANTERIOR BAND WIRING



Partial patellectomy is indicated when there is severe comminution of one pole that is not amenable to internal fixation.

Total patellectomy has been recommended for highly displaced, comminuted patella fracture, where reconstruction of patellar surface is not possible and those fractures that are not amenable to internal fixation.

After treatment: The limb is placed in extension in a posterior splint or knee brace. Isometric exercises are started on the first postoperative day. Active range of motion is performed when the wound had healed approximately after two to three weeks.

The brace is discontinued at 6-8 weeks.

COMPLICATIONS OF PATELLAR FRACTURES

1. Fracture fragment separation and dehiscence of the fracture repair are uncommon.

They generally result from either inadequate internal fixation or, in some cases, an inadequate period of postoperative joint support. Nummi reported a 7.4%

incidence of late displacement after treatment of patellar fractures by closed methods. He noted an 11% incidence of loss of fragment position after osteosynthesis.

2. Refractures are rare in nearly all series; the incidence varies from less than 1% to 5%. The trauma responsible for refracture is usually minimal. Treatment must be individualized to the patient. Repeat osteosynthesis may be necessary for moderate displacement and extensor mechanism insufficiency.

3.Avascular necrosis is reported by most authors to be rare; however, Scapinelli reviewed 162 transverse fractures of which 41 showed partial evidence of necrosis; 38 of these involved the proximal fragment. Treatment consists of observation only. Patients usually regain full knee function within 6 to 8 months, and varying degrees of patellofemoral arthritis usually develop. Revascularization usually occurs spontaneously within 2 years.

4.Patellofemoral pain or osteoarthritic symptoms may develop as late sequelae of patellar fracture. Nummi reported a long-term incidence of patellofemoral arthritis of 56.4% in more than 700 fractures. Conservative management of patellofemoral joint pain using non-steroidal anti-inflammatory agents and physical therapy is the mainstay of treatment. Under certain circumstances, the anterior tibial tubercle advancement advocated by Maquet may provide resolution of symptoms and improved extensor mechanism function; this is usually indicated in young patients with intractable knee pain.

5.Postoperative wound infection is managed by debridement and evaluation of the stability of the fixation. Wound infection with stable fixation and viable bone fragments is treated by debridement, irrigation, and closure over drains with intravenous antibiotics. Persistent infection in the presence of devitalized bone fragments requires excision of nonviable bone and plastic repair of the extensor mechanism. Any exposure of the knee articular cartilage to chronic infection results in progressive deterioration of both knee function and joint space. After repair of the residual extensor mechanism, the knee is immobilized until healing occurs. Partial to total patellectomy may be required to gain control over the infection process. Loss of knee function and degenerative changes are common sequelae.

6.**Non-union**: There is a low incidence (2.4%) of patellar fracture nonunion. Nonunion may be well tolerated by patients with limited or decreased functional demands on the knee. Nummi reported 14 of 17 non-unions as having satisfactory results. Repeat osteosynthesis may be indicated to obtain union in more active, young individuals. Partial patellectomy may be considered in the painful nonunion associated with avascular necrosis.

7.Painful retained hardware is common and is usually related to tendon or capsular irritation from Kirschner-wire penetration or the twisted ends of cerclage wires.

Removal of the hardware usually alleviates these symptoms. Fractures of the cerclage wire are managed by removal if symptomatic. Cancellous 4.0- or 3.5-mm lag screws are difficult to remove if left for several years within hard young bone.

IMPLANT BREAK

MATERIALS AND METHODS:

The study will be conducted in Coimbatore medical college and hospital during the period 2012-2015. 20 patients with transverse fractures will be included in the study.

Inclusion criteria:

1. Age above 16 years

2. Includes both sex

3. Fresh and old fractures

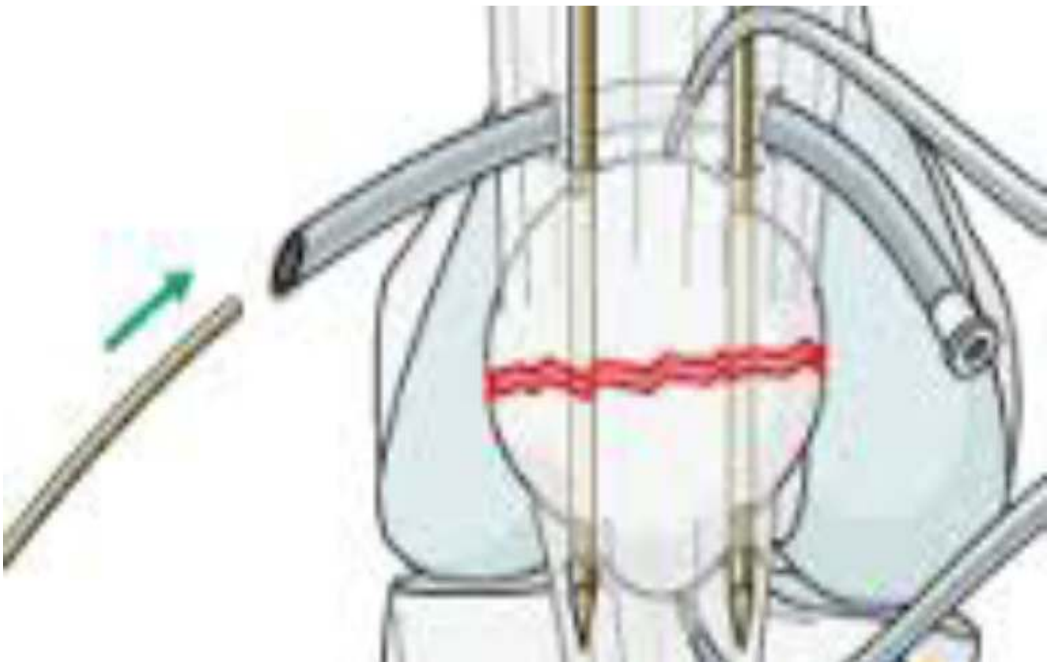
Exclusion criteria:

1. Age less than 18 years

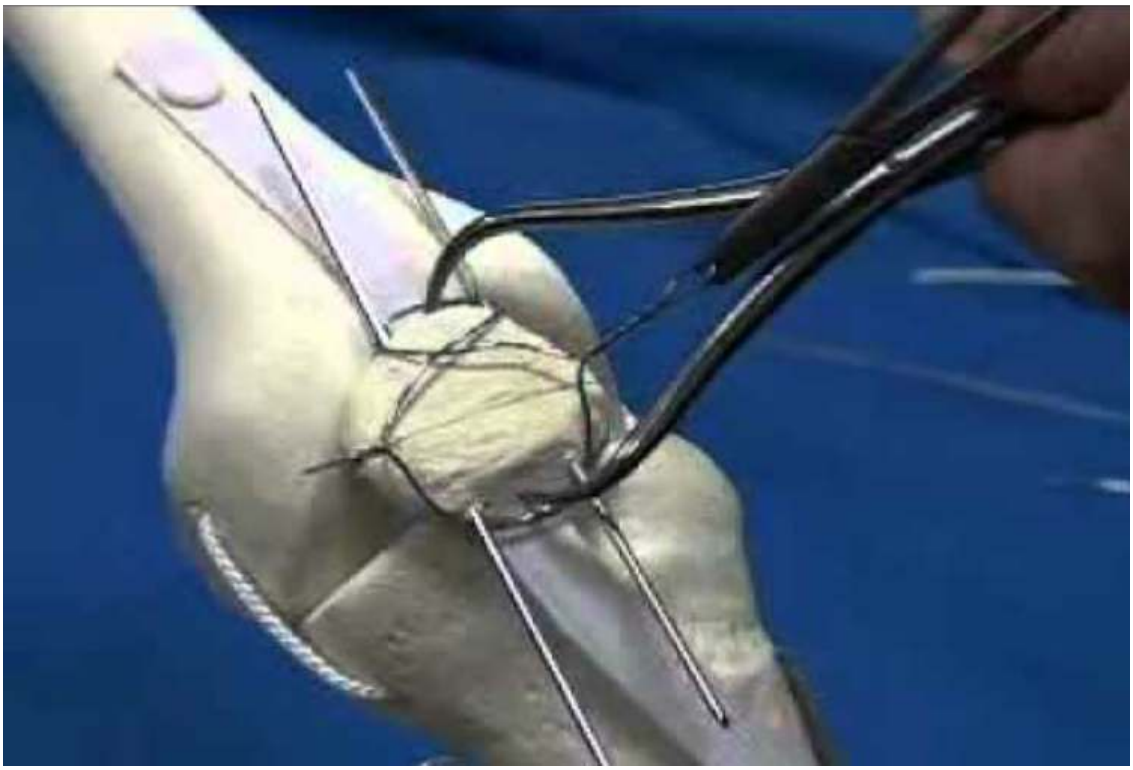
2. Infected fractures

INSTRUMENTS AND IMPLANTS

SS WIRE PASSER AND PATELLAR CLAMP



Patellar clamp helps in maintaining reduction while introducing k-wire and ss wire



Patellar claw can also be used to maintain reduction intraoperatively

PATELLAR CLAW

STUDY DESIGN:

This study was a prospective clinical study to be conducted at the Department of Orthopaedic Surgery, Coimbatore Medical College Hospital from 2012 to 2015

STUDY PROCEDURE:

Preoperatively the patient will be evaluated by taking detailed history, general, local and Radiographic evaluations. Patient will be prepared in a conventional way in operation theatre.

Through a midline longitudinal incision over the patella, Fracture fragments will be exposed. Fracture fragments will reduced by using patellar clamps and fixed with two parallel 2mm K-wires from inferior to superior borders. Then an 18 gauge ss wire will be introduced in a figure of 8 fashion and tightened at the upper end.

Proper reduction will be checked by palpating the undersurface of patella with the knee extended.

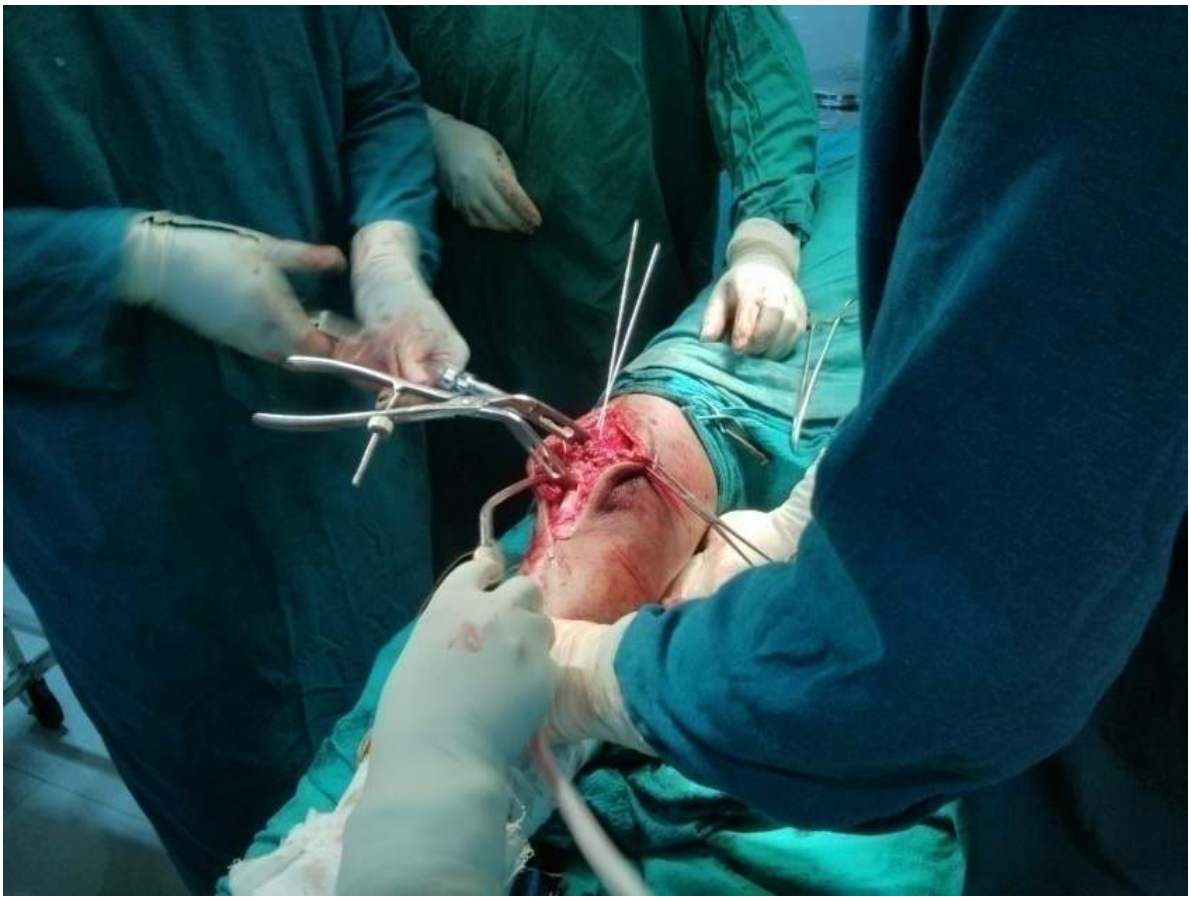
OPERATIVE TECHNIQUE

Patient positioning and draping-supine position

Skin incision and exposure of fracture fragments

Reduction achieved and maintained using patellar clamp

K-wires and SS wires introduced



Reduction checked by palpating the undersurface of patella with knee in extension

Skin closure

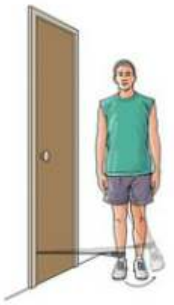
Rehabilitation protocol will be started on 3rd day. Quadriceps strengthening exercise, progressive straight leg raising (SLR) with weight, range of motion (ROM) exercise and full weight bearing walking will be taught.

Broken Kneecap (Patellar Fracture) Rehabilitation Exercises

Knee stabilization: A

Knee stabilization: B

Knee stabilization: C



Knee stabilization: D

Resisted terminal knee extension

Standing calf stretch

Clam exercise

Iliotibial band stretch (side-bending)

Patella self mobilization

Broken Kneecap (Patellar Fracture) Rehabilitation Exercises

Standing hamstring stretch

Quadriceps stretch

Side-lying leg lift

Quad sets

Straight leg raise

Step-up

Wall squat with a ball

FOLLOW UP EVALUATION:

Follow up will be in, 4^{th}, 8^{th} , 12^{th} and 16^{th}weeks

The results were evaluated according to:

Reich and Rosenberg (1954) for patellar fractures.

Reich and Rosenberg (1954) - Patella

Results	Pain	Movement
Excellent	No pain or occasional	No limitation
Good	Pain on prolonged activity	Limitation of last 10^0-20^0 of flexion
Fair	Pain while climbing or during work	Flexion > 75^0
Poor	Constant pain	Flexion < 75^0

RESULTS

The present study consisted of 20 cases of fractures of Patella treated by modified tension band wiring Coimbatore medical college and hospital during the period 2012-2015. The following observations were made in the present study.

Table : 1

Age incidence

Sl. No.	Range of age	No of Patella Fractures
1	21 – 30	2 (10%)
2	31 – 40	5 (25%)
3	41 – 50	5 (25%)
4	51 – 60	5 (25%)
5	61-70	3 (15%)

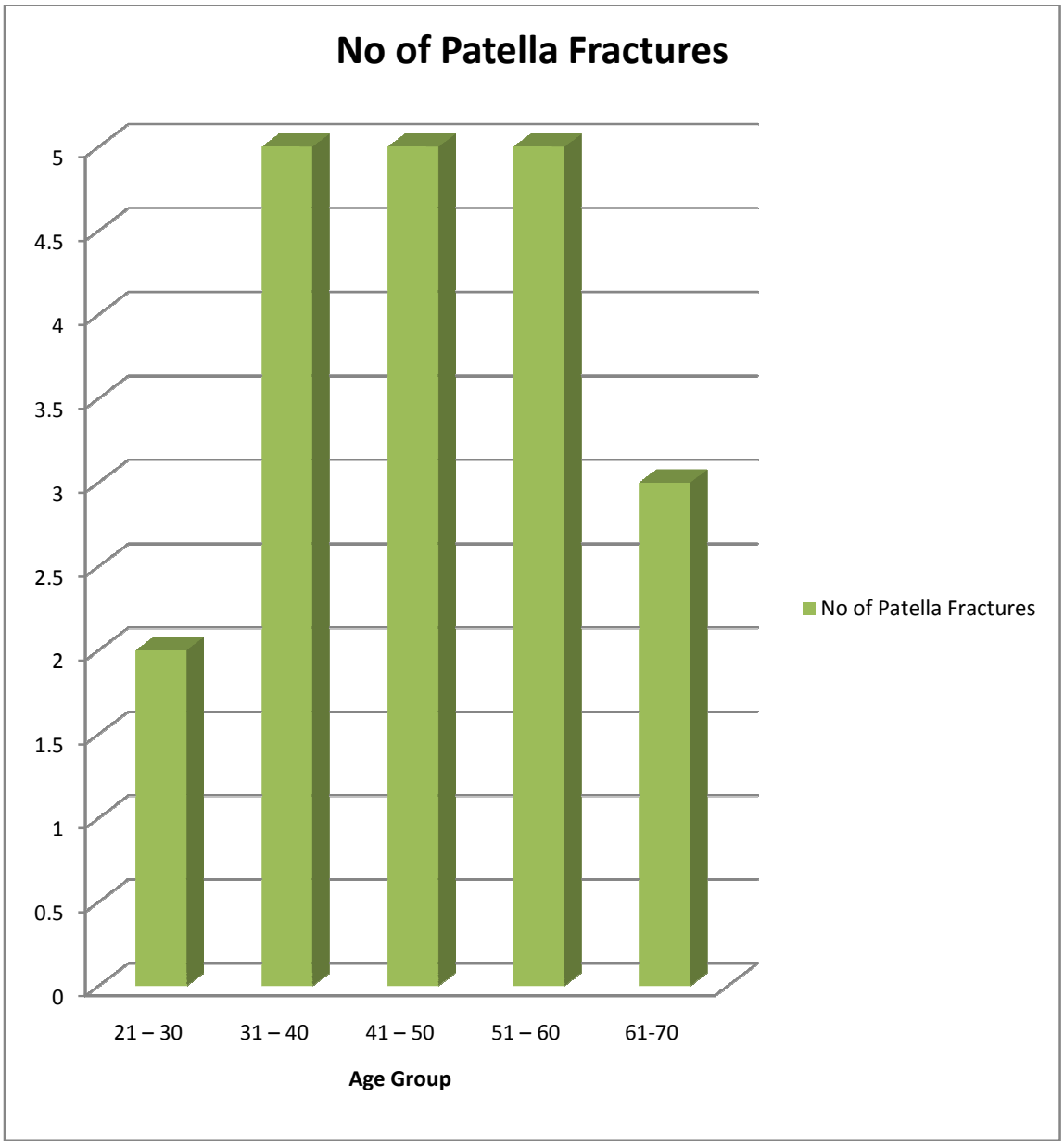

No of Patella Fractures
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
21 – 30
31 – 40
41 – 50
51 – 60
61-70
Age Group
No of Patella Fractures

Table : 2

Sex Incidence

Total No of Patella Fractures	Male (%)	Female (%)
20	16 (80%)	4 (20%)

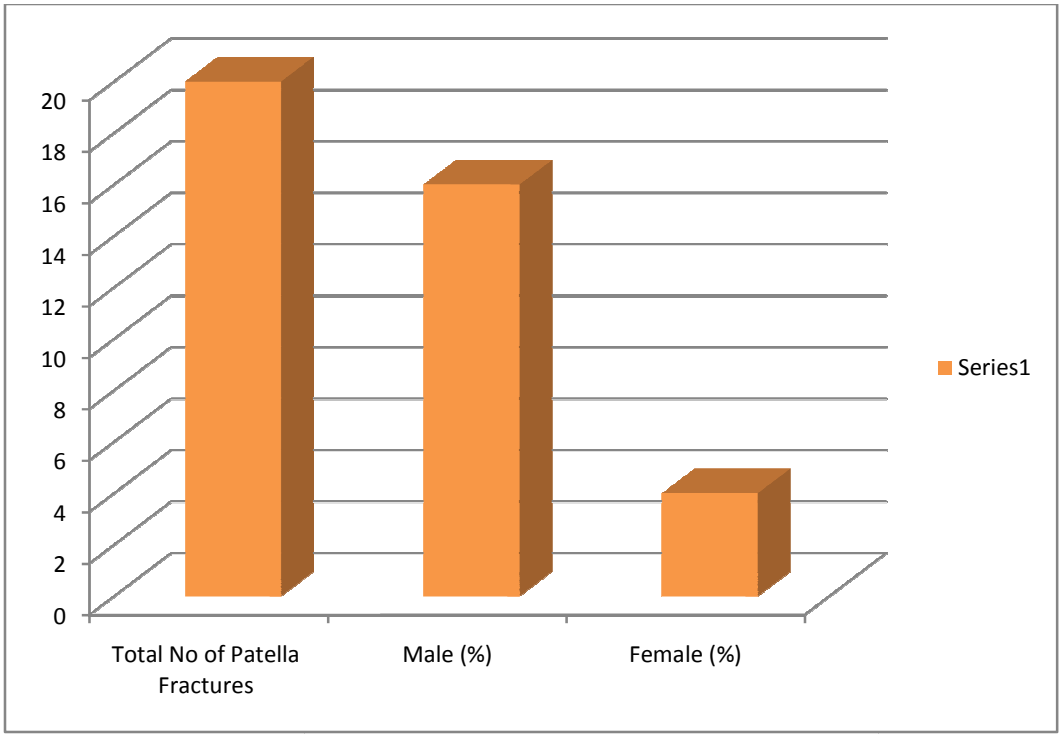


Table : 3

Side Incidence

Total No of Patella Fractures	Right side (%)	Left side (%) 1
20	6 (30%)	14 (70%)

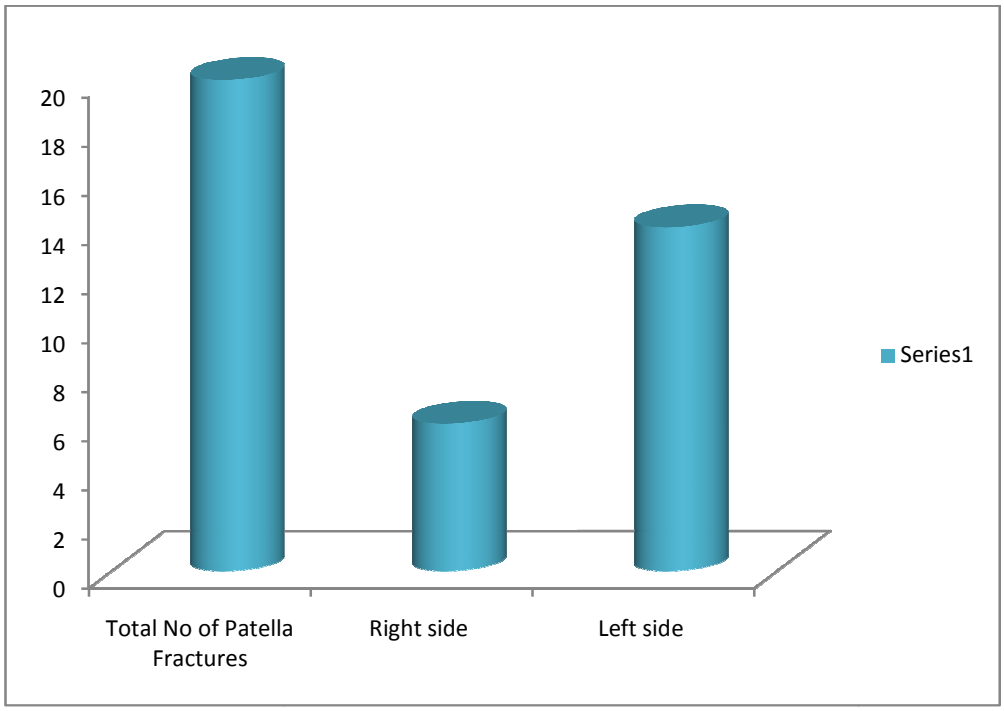


Table : 4

Mechanism of Injury

Total No of Patella Fractures	Direct trauma (%)	Indirect trauma (%)
20	8 (40%)	12 (60%)

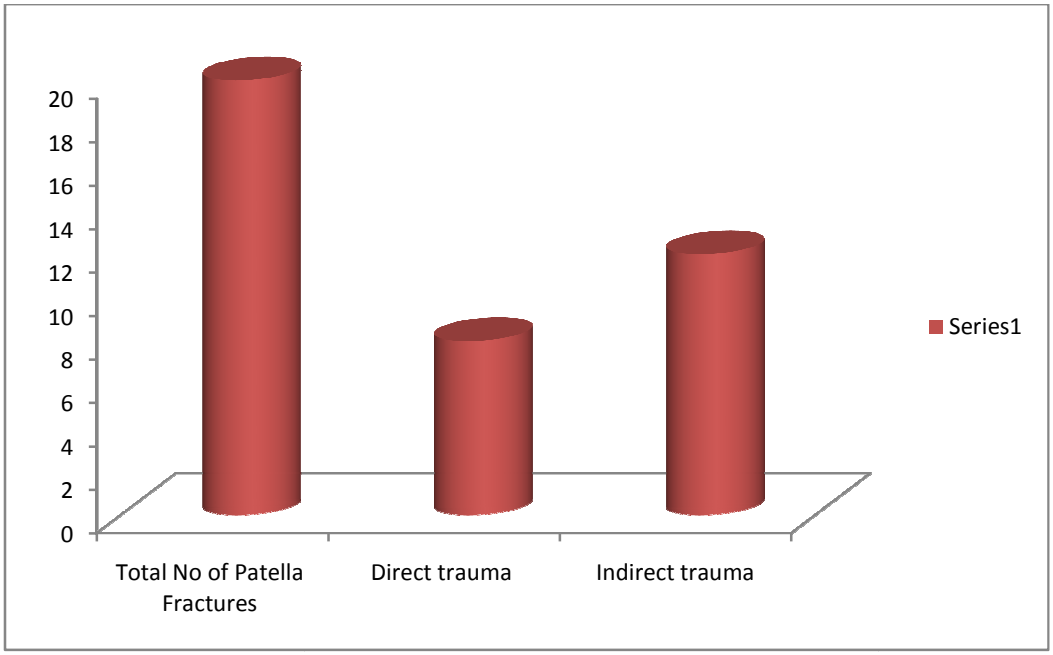


Table : 5

Mode of injury

Sl.	Mode of injury	Patella
1	Slip	6
2	RTA	14
3	Assault	-
4	Sports	-

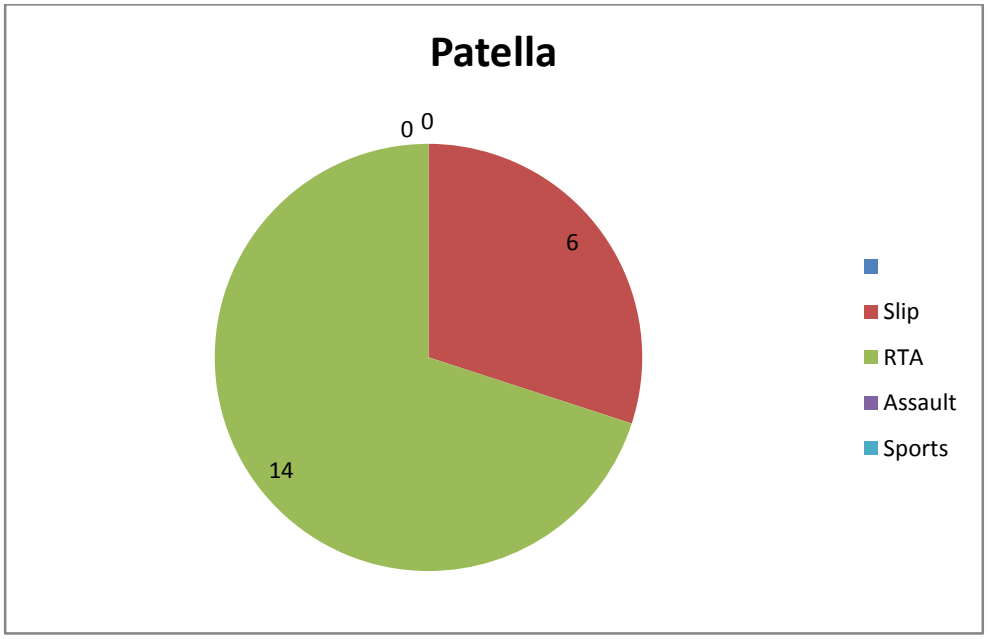


Table : 6

NATURE OF INJURY

Total no of patella fractures	Simple(%)	Compound(%)
20	16(80%)	4 (20%)

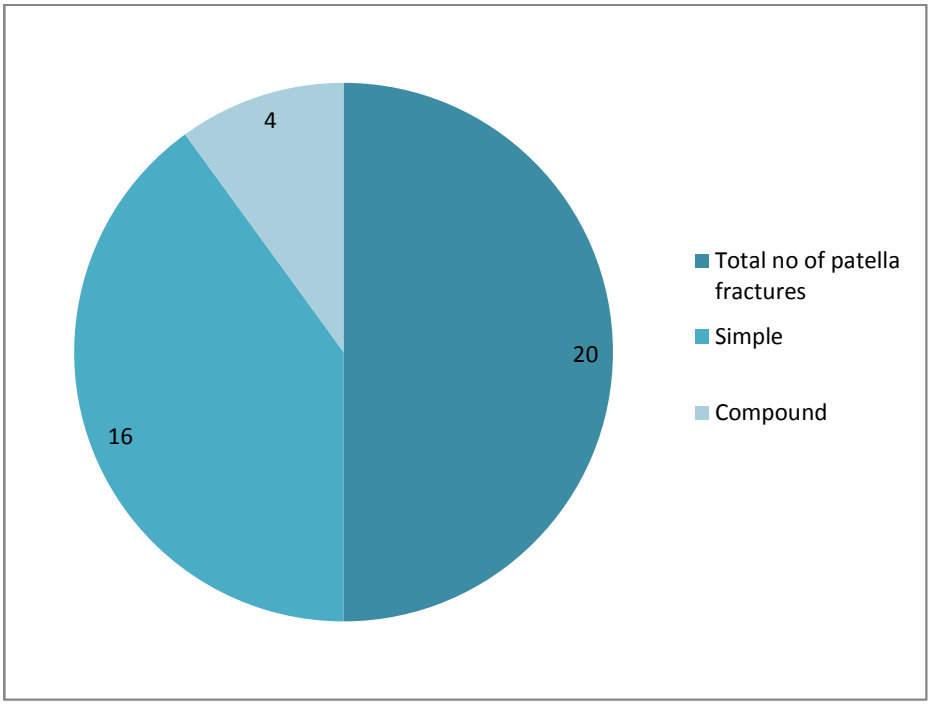


Table : 7

TYPE OF FRACTURE

Total no of patella fractures	Tranverse(%)	Oblique(%)	Communitede(%)
20	12(60%)	4(20%)	4(20%)

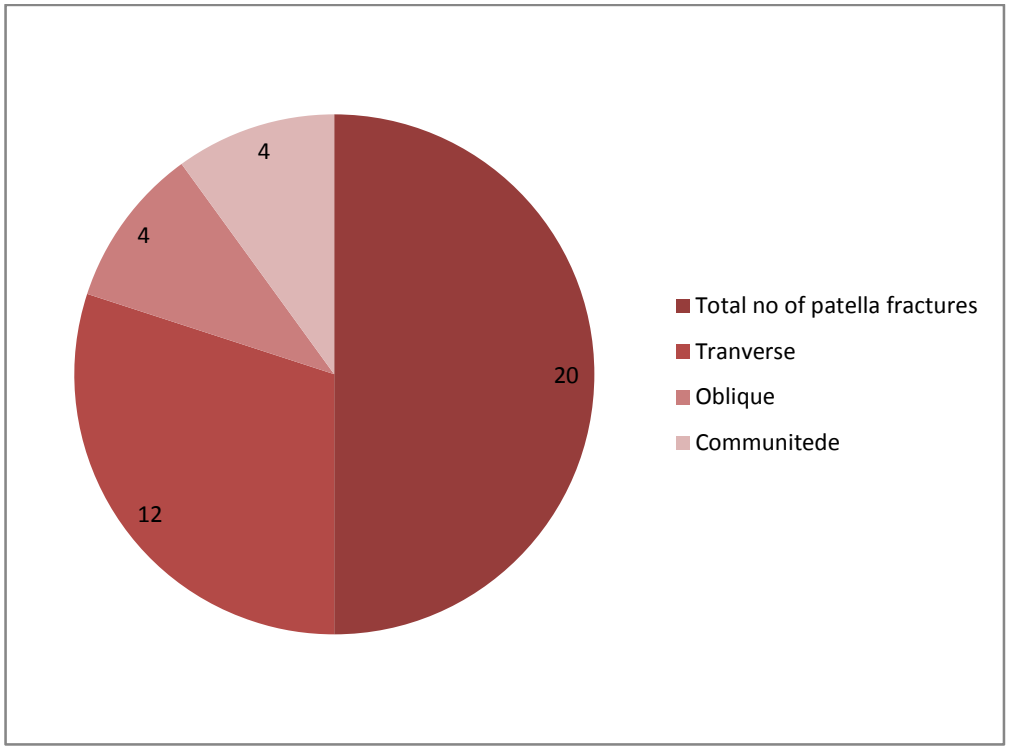


Table : 8

TIME INTERVAL BETWEEN INJUERY AND SURGERY

SLNO	DURATION	NO OF PATELLA OF FRACTURES
1	within 48 hours	2(10%)
2	2-10 days	16 (80%)
3	11-20 days	2 (10%)

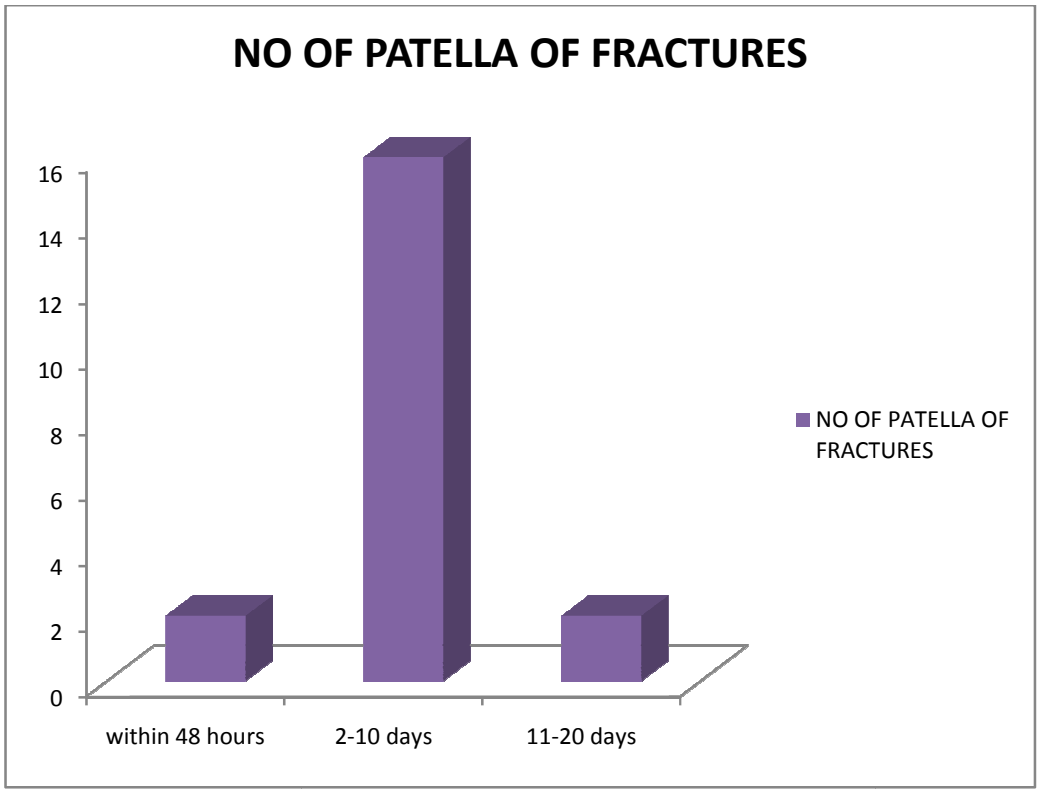
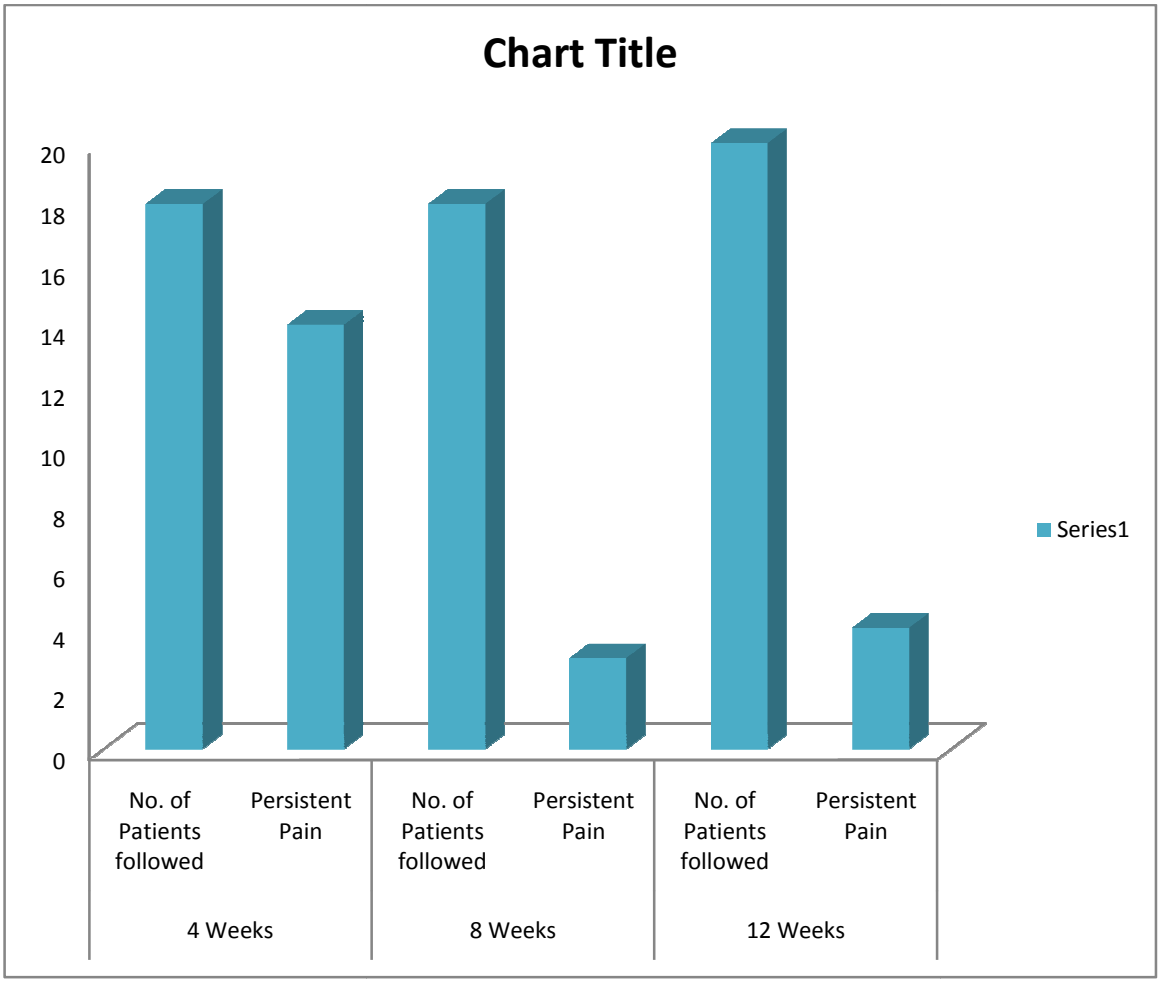


Table : 9

Total No of Patella Fractures	4 Weeks		8 Weeks		12 Weeks	
	No. of Patients followed	Persistent Pain	No. of Patients followed	Persistent Pain	No. of Patients followed	Persisten t Pain
20	18	14 (77.77%)	18	3 (33.33%)	20	4 (20%)



Pain and tenderness declined with progress of postoperative period but persisted in 26% of cases after 12 weeks. In most of patients pain persisted for 4 weeks, which decreased after 8 weeks.

In first 4 weeks and 8 weeks, one patient with patella fracture did not turn for follow up who were followed up at 12 weeks

Table : 10

Movements - Patella

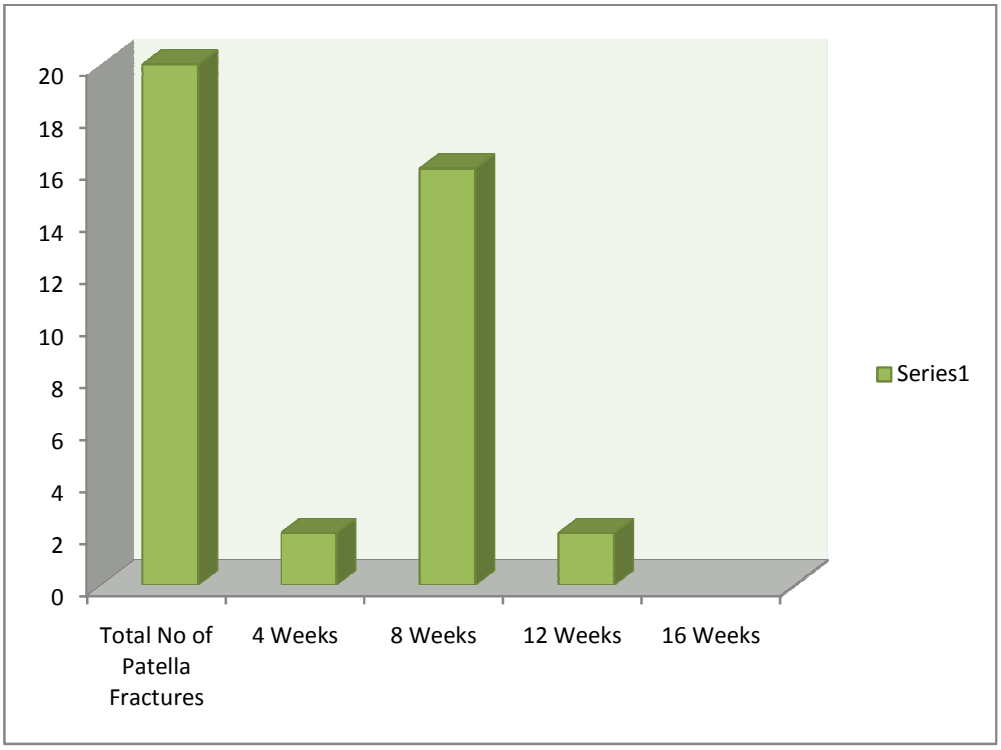
Sl. No.	Duration (weeks)	No. of patients	Range of motion – Knee flexion	No. of patients (%)
1	4	18	No restriction	-
			Restriction of last 10-20^0	4 (22.22%)
			Restriction of 20^0-50^0	6 (33.33%)
			Restriction >50^0	8 (44.44%)
2	8	18	No restriction	8 (44.44%)
			Restriction of last 10-20^0	4 (22.22%)
			Restriction of 20^0-50^0	4 (22.22%)
			Restriction >50^0	2 (11.11%)
3.	12	20	No restriction	16 (80%)
			Restriction of last 10-20^0	2 (10%)
			Restriction of 20^0-50^0	2 (10%)
			Restriction >50^0	-

In our study about 83% of cases had full range of movements at 12 weeks.

Table : 11

Radiological Union

Total No of Patella Fractures	4 Weeks	8 Weeks	12 Weeks	16 Weeks
20	2 (10%)	16 (80%)	2 (10%)	-

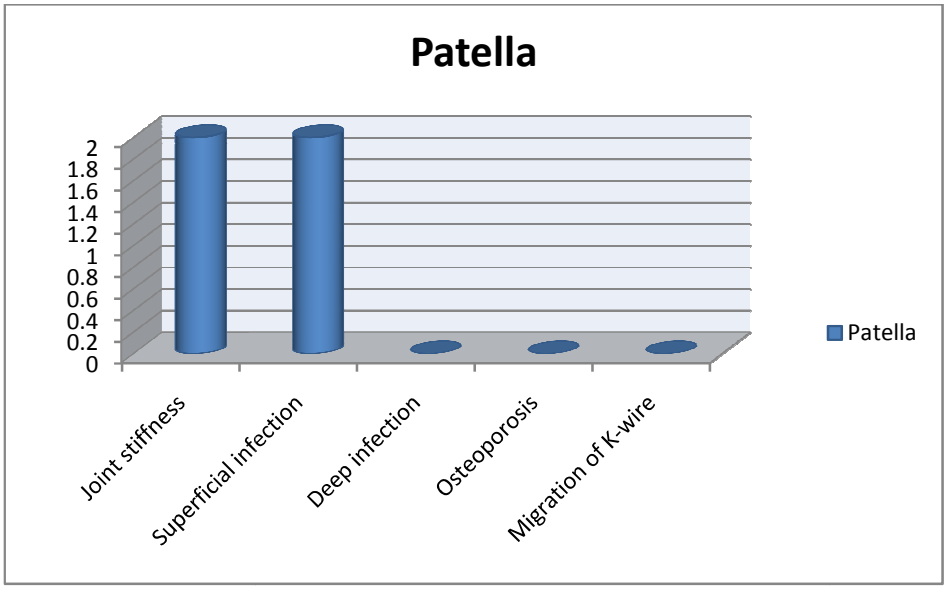


In our study 80% of radiological union of fracture was seen by 8 weeks

Table : 12

Complications

Sl. No.	Complications	Patella
1	Joint stiffness	2 (10%)
2	Superficial infection	2 (10%)
3	Deep infection	-
4.	Osteoporosis	-
5.	Migration of K-wire	-

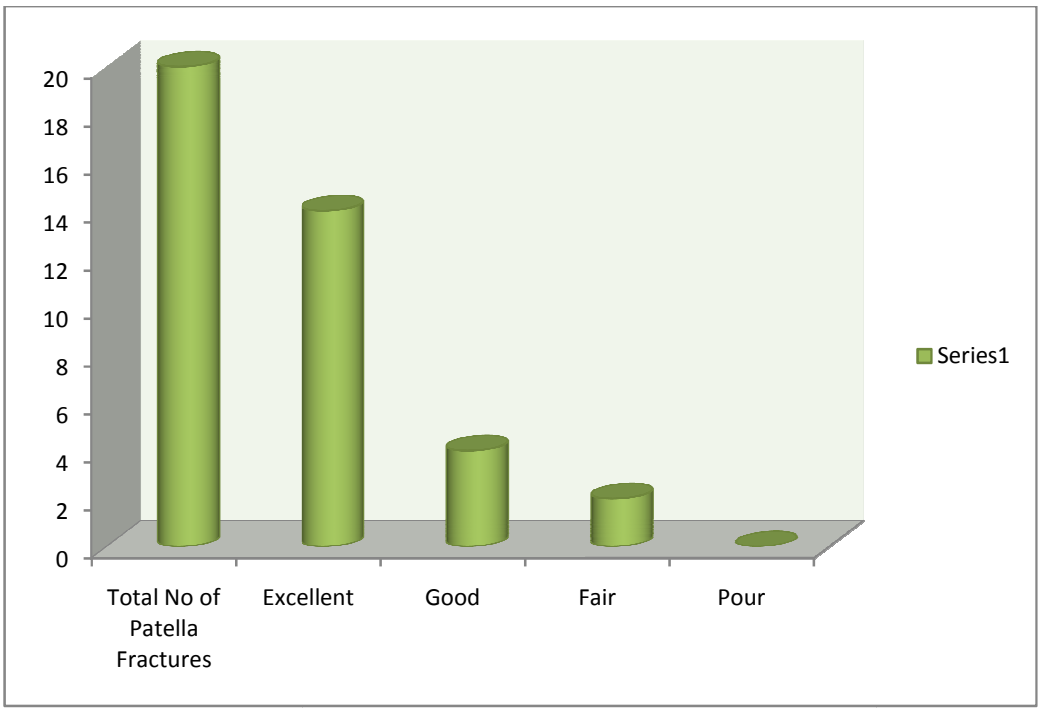


One patient developed superficial infection of prepatellar bursa. Joint stiffness was seen in 1 patient of patellar fracture which recovered after physiotherapy.

Table : 13

Evaluation of Results

Total No of Patella Fractures	Excellent	Good	Fair	Poor
20	14 (70%)	4 (20%)	2 (10%)	-



Results were done according to criteria outlined in the methodology. In our study, best results were obtained in fracture of patella 70%.

DISCUSSION

The aim of treatment of fracture is not only achieving union but also to preserve the optimum function of adjacent joints. In intraarticular fractures of patella, it is important to maintain perfect anatomical reduction of fragments to obtain articular congruity by rigid fixation. The treatment of choice for these fractures by AO group is modified tension band wiring.

Modified tension band wiring was made use in our 20 cases. It has given favourable results in our experience. The findings, end results and other data will be analyzed and compared in the following discussion.

Age

The average age in present series was found to be 40.1 years which is in accordance with series mentioned below:

Table 20
Age Incidence

Sl. No.	Series	Average age
1.	Maini and Kochar	35.7 years
2.	Bostman	42.0 years
3.	Gary Wolfgang	40.5 years
4.	Daniel F. Murphy	43.3 years
5.	Levack	49.0 years
6.	Present study	40.1 years

Sex

In present study, fracture incidences are more in males (80%)and females (20%).Similar sex incidence was found in study made by Pandit and Shah, Maini and Kochar. This indicates males are more exposed to trauma.

Table 14

Sex Incidence

Series	Fracture	Male (%)	Female (%)
Srinivasulu	Patella	81.81	18.19
Maini and Kochar	Patella	75	25
Present study	Patella	80	20

Side

In present study left side(70%) is involved more than right side(30%).Other series (Maini and Kochar, Gary Wolfgang) have reported higher incidence of fracture on left side. It may be due to the fact that the left non-dominant side makes vulnerable for trauma.

Table 15

Side Incidence

Series	**Fracture**	**Right (%)**	**Left (%)**
Maini and Kochar	Patella	55	45
Present study	Patella	30	70

Mechanism of injury

Indirect trauma was more common in our study (60%), the common mode of injury being road traffic accident..

Table 16

Mechanism of injury

Series	Direct (%)	Indirect (%)
Srinivasulu	50	50
Maini and Kochar	65	35
Pandit, Shah	20	80
Gary Wolfgang	7	93
Present study	40	60

Nature of injury

Simple injuries (80%)were more common than compound injuries (20%) in our series. Gary Wolfgang, Pandit and Shah reported high incidence of compound injuries in their series.

Table 17

Nature of injury

Series	Simple (%)	Compound (%)
Srinivasulu	-	-
Maini and Kochar	92	8
Pandit, Shah	80	20
Gary Wolfgang	68	32
Present study	80	20